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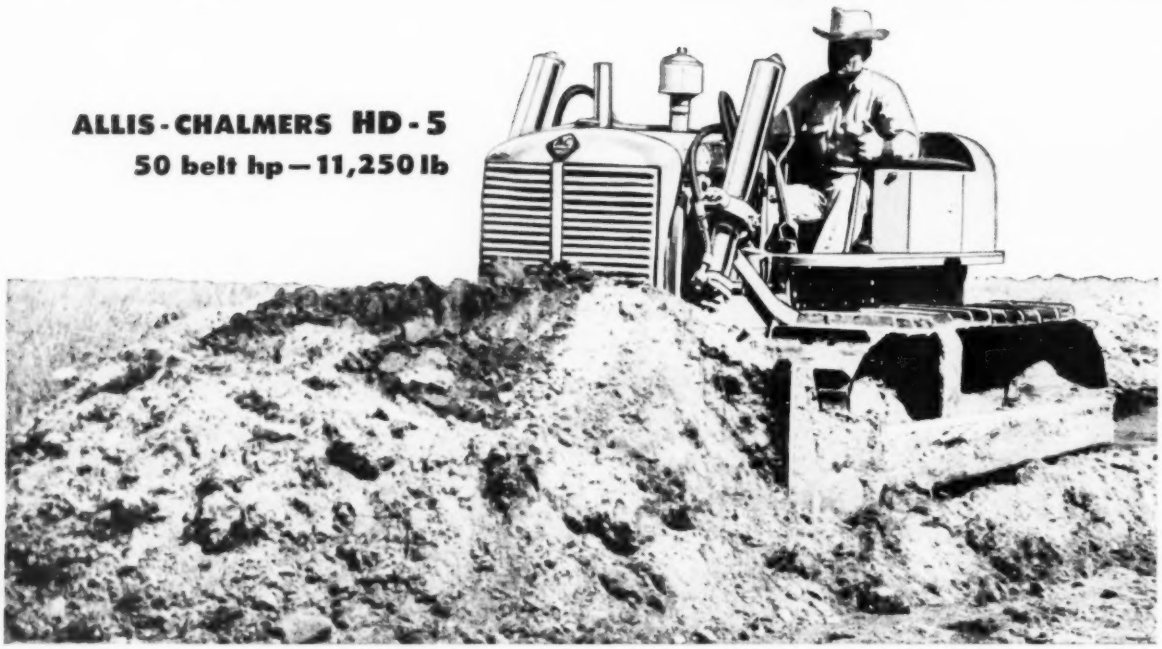

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The Scope of Forest Genetics[1]

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THERE seems to be no doubt that even the most ancient foresters were perfectly aware of the basic biological fact that "like begets like." They must also have made the equally fundamental observation that, although the sexually produced offspring of trees and other organisms are very much like their parents, they are never *exactly* like them.

The study of these phenomena—the conservative influences of heredity on the one hand, and the opposing forces of variation on the other—make up that branch of biology called *genetics*. We are here concerned with a consideration of the role of *forest genetics* in forestry; and I, specifically, have been assigned the task of defining the scope of its applications in silviculture. In addition, I think it may be helpful to clarify certain of the technical terminology, and review briefly some of the genetic concepts that will inevitably enter into this panel discussion.

Genetic Background

Modern ideas of heredity are based on the experimentally verified fact that the hereditary characteristics transmitted from parents to offspring consist of discrete unit particles, called *genes*. During the growth and development of the organism, these particles react in a specific way to specific environmental factors. Thus, *all* of the traits exhibited by an organism at any particular age or stage of development represent the end product of interactions between its complement of genes and the environment in which it has grown.

As a means of distinguishing concisely between the inherited constitution of an individual and the resulting end product of its interaction with the environment, geneticists employ the term *genotype* to designate the sum total of the hereditary factors or genes which an individual receives from its parents. The term *phenotype* is used to designate the sum total of the individual's external and internal, visible and measurable traits of form, color, size, etc., resulting from interactions between the individual's genotype and the environment.

We recognize different individual trees or humans by their phenotypes. Their genotypes, on the other hand, cannot be observed directly, but can be inferred only from a study of their ancestry or offspring. Unlike the phenotype, which in certain aspects may change markedly with age, the genotype is stable throughout the life of the individual, except for rare changes known as *mutations*.

From the foregoing definitions, it is clear that major differences in the phenotypes of two individuals may be attributable to one or both of two general causes: (1) the genotypes are different, or (2) the environments in which they have grown are different. Although in nature phenotypic diversity is usually traceable to both causes, there is little difficulty at the species level in distinguishing variations which are chiefly genotypic from those which are environmentally induced. In a mixed forest, for example, several species may grow together under an essentially uniform environment. The major cause for diversity of phenotypes in such cases is obviously due to genotypic differences.

Below the species level, different individuals or groups of individuals frequently have different heredities as well. In such cases the difficulties of distinguishing between genotypic and environmental variations are much greater, and considerable caution must be exercised to avoid ascribing genotypic variations to environment, and vice versa.

Species occupying a wide geographic range or a wide variety of local habitats are those which frequently show marked morphological or physiological diversity in genotype. For this reason, seed source is a matter of primary concern in the successful establishment of forest plantations. And for the same reason, the tree breeder is continually on the lookout for new and promising genetic variants which he may select from wild populations of the species with which he is concerned.

In the terminology of genetics, the phenotypic expression of traits which are traceable to environmental differences are said to be *modifications* or *fluctuations;* whereas those which are due to genotypic differences are called *variations*.

Since the phenotype of an individual is the result of the interaction of its genotype with the environment, and since the range of possible environments in the world is very great, the same genotype is capable of producing many different phenotypes. The actually realized or potentially possible phenotypes of any particular genotype constitute its *range of reaction*. Of special practical interest is the fact

[1]Slightly modified text of paper presented as part of panel discussion on Forest Genetics before the Division of Silviculture, annual meeting S.A.F., Colorado Springs, Colo., September, 1953.

that the reaction range of specific traits may vary widely. Some, such as growth rate, are extremely plastic or "loosely controlled" by the genotype; others, such as flower morphology, are "rigidly controlled," and thus show great constancy of phenotype under a wide range of environments. On the basis of this distinction, the traits of organisms are sometimes classified as "hereditary" (i.e., rigidly controlled) or "nonhereditary" (i.e., loosely controlled).

Applications in Silviculture

Although definitions of silviculture are numerous and variable, a stated or implied objective of most of them is the improvement in quality and yield of the present and future generations of trees. Such improvement in tree phenotypes may obviously be attained in two general ways: (1) by improving the genotypes, or (2) by providing a more suitable environment. Theoretically, of course, the biologically sound method is to utilize both of these mutually complementary techniques whenever possible.

In the naturally regenerated forest, there is nothing, short of clear-cutting and planting, that can be done to change the genotypes of the trees currently occupying the area. Any improvement in phenotypes must, perforce, be of the nature of modifications, effected by manipulation of the environment. If this is to be done economically and well, some fore-knowledge must be available of the results that may be expected. In other words, accurate information on the *reaction range* of various traits for the species concerned is essential.

The amount of sound silvical knowledge at present available on the reaction range of various tree characteristics is appallingly inadequate. My personal impression is that one of the most valuable contributions forest genetic research can make in silviculture is to increase the quantity and improve the quality of our silvical knowledge.

Although manipulation of the forest environment is ineffective as a means of inducing changes in individual genotypes, the silviculturist is nevertheless able to exert a direct and controlling influence on the genetic composition of the whole stand, and, in consequence, on the succeeding generations as well. In the practice of his art, manipulation of the environment is effected chiefly by use of the axe or saw. By these means the genetic quality of the stand may be greatly altered. Whether the direction of this change is good or bad depends entirely on the soundness of the selection criteria employed. Silvical knowledge in this respect is at present so deficient that questions of genetic improvement in self-reproduced stands are still essentially academic.

Enrichment of our silvical knowledge may, if expertly used, be expected to result in marked improvement of both present and future stands. But it must be realized that individual tree or stand quality has little chance for improvement beyond the best of the wild type. Such limited improvement for much of our forest area must doubtless suffice for the present.

Locally, however, the genetic quality of the residual stands may be so low that more intensive improvement efforts are needed. For such areas, and for those which have been completely denuded of their trees, planting is necessary. Under such conditions the planting stock utilized should obviously be grown from the genetically most desirable seed available. For the present such seed requirements must be supplied from suitable wild sources. The criteria of suitability should, ideally, be based on the performance of progeny from controlled pollinations; but lacking such refinement, seed collections should at least be confined to the phenotypically high quality individuals or stands of local origin.

Eventually, through the application of breeding methods, we may expect to produce high yielding and otherwise desirable genotypes at will.

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A Note About This Special Issue

In recognition of the rapidly increasing interest throughout the forestry profession in forest genetics and tree breeding, the editors of the JOURNAL OF FORESTRY proudly present in this issue a symposium on developments in tree improvement. In addition to the several leading articles on research and the application of genetic principles in silviculture, there will be found in the Notes Section a summarization of developments by regions in the United States and Canada. To Philip C. Wakeley, who since last January has been the JOURNAL's first associate editor for forest genetics and artificial regeneration, special credit is due for helping round up the articles comprising this issue.

Extra copies of this issue are available at the standard rate of 75 cents per copy.

The Importance of Species Hybridization and Polyploidy in Forest Tree Improvement[1]

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University of Washington, Seattle.

SPECIES HYBRIDIZATION is a means toward forest tree improvement which is effective in certain genera under certain circumstances. There is no single means toward forest tree improvement which is most effective in all circumstances.

I propose to show what can be expected of a species hybridization program, first in short-term gains, and second in the long run—sometimes held to be the long suit of foresters. I shall draw on the pine hybridization program of the Institute of Forest Genetics for examples.

Since we are to consider hybridization as a means toward an end, we should define the end. We seek a population of gentically improved trees. Such a tree possesses a better than average combination of characters as a result of the reaction between the environment in which the tree is situated and the combination of genes which it carries in its nuclei. If we regard the environment as a constant it is seen that the genetically significant feature of an improved tree is a favorable combination of genes. Thus, the central problem in genetical improvement is to choose the most effective means of locating in the woods, or creating from scratch, these favorable gene combinations. Species hybridization does not contribute to the locating process; it is a means of creating new combinations, or, possibly, of recovering lost combinations.

The cross between Jeffrey and Coulter pines offers a new gene combination advantageous to the forest manager. Jeffrey pine, like its better-known relative ponderosa pine, is a tree of excellent technical and silvicultural properties, but highly susceptible to killing by the pine reproduction weevil. Coulter pine is resistant to the attacks of this weevil and is much faster-growing, as a young tree, than Jeffrey pine. It is, however, usually a tree of rapid taper, clothed with numerous heavy branches, and less resistant to cold than Jeffrey pine. Hybrids between Jeffrey and Coulter pines are intermediate between these species in growth rate, produce fewer branches per year than Coulter pine, and hence fewer per unit length of trunk than Jeffrey pine. Most important, these hybrids, in a series of tests initiated in 1946 by John M. Miller of the Bureau of Entomology and Plant Quarantine, have been found to inherit the weevil resistance of Coulter pine. Here, then, is a species hybrid combining the desired characters of both parents in such a way that it may be used directly in forest plantations. To date, more than 30 thousand seedlings of this hybrid, derived from hand pollinations, have been interplanted in five of the national forests of California, while at least 20 less extensive field tests of this cross have been established in California and elsewhere.

Hybrid vigor is a term used to describe a plant which out-performs both its parents in growth rate, resistance to adverse environmental factors, or production of some substance. A more general definition would specify that the mean of a hybrid progeny should exceed the mean of each of the parental species or varieties. This definition is probably satisfactory for annual plants. It is not adequate for forest trees for it largely ignores time, the dimension which makes silviculture the most difficult and fascinating of the plant production arts. Closely related species often differ in the course of their growth curves. Thus a hybrid progeny may be intermediate between its parents at one stage in its development, but may exceed both at a different stage. This may be the case with the hybrid between Pacific Coast ponderosa pine and Apache pines. Therefore, a practical definition of hybrid vigor in forest trees should specify the rotation age. Finally, the environment in which comparative tests are made should be specified; a progeny exhibiting hybrid vigor on one site may not do so on a different one. Several pine hybrids seem to show hybrid vigor in volume growth. These are generally crosses between species which resemble each other closely, but are distinctly or widely separated geographically. Examples are the lodgepole-jack pine hybrid, the western-eastern white pine hybrid, and the crosses of the Himalayan white pine with eastern and western white pines. So far there is little evidence to suggest that hybrid vigor will be found in crosses between species of pines growing in the same general area. These generalizations on hybrid vigor in pines may be valid also for larches, birches, and aspens.

Some results of the pine crossings made at the Institute of Forest Genetics, as well as birch and aspen crossings by the Cabot Foundation, show that the performance of species hybrids is greatly influenced by the racial origin of the parents. Western white pine of western Washington origin produces much faster growing hybrids when crossed with eastern white pine than does western white pine of Sierra Nevada origin. The species hybridizer cannot escape the provenance problem. The foregoing illustrate two important aspects of hybrid vigor in relation to tree improvement. First, there are definite possibilities for utilizing this poorly understood genetic phenomenon. Second, careful, extensive, and long-term testing is required before one can credit a given species or variety cross with hybrid vigor and even then, the claim must be properly qualified.

I have described two types of hybrids having practical value: those with favorable character combinations and those with hybrid vigor. How can these potential values be realized over large areas of planted forest? For poplar and

[1]Slightly modified text of paper presented as part of panel discussion on Forest Genetics before the Division of Silviculture, annual meeting, Society of American Foresters, Colorado Springs, Colo., September 1953.

willow hybrids, readily propagated by cuttings, the problem has already been solved. With trees for which seed propagation is the only practical method at present there are difficulties, some real and some fancied. Some of these difficulties also beset tree improvement programs not based on species hybridization. Most hybrids—either species crosses or hybrids in the more general sense of crosses between two genetically unlike individuals—do not breed true. For the practical use of species hybrids, this difficulty may prove to be more fancied than real. Righter has shown that genetic uniformity is not required in the forest to the extent considered desirable in many agricultural crop plants. Stevens and Hartley have gone further to argue that security of a long-cycle crop may depend heavily on genetic diversity. If, then, we are willing to use the comparatively heterogeneous progenies of species hybrids, achieving, if we wish, a degree of uniformity by stock-culling and intermediate cuttings, the problem of using hybrids extensively becomes one of seed orchard technology. A seed orchard of lodgepole-jack pine hybrids at the Institute of Forest Genetics has been producing low-cost second generation or F_2 hybrid seed for several years. Widely scattered tests of this F_2 hybrid suggest that it may be a rapid pulpwood producer in the Pacific Northwest, the Lake States, and the Rocky Mountain region.

How do we produce species hybrids? Obviously, one would say, you take pollen from one species and place it on the flowers of another. Sometimes this is done using "wild" trees; more often hybridization, both natural and intended, has been the consequence of some visionary individual who collected all the species he could in an arboretum. Intended hybridization is usually the result of curiosity stimulated by the close proximity of two species which do not normally grow together. This is the elementary level at which arboreta play a part in tree improvement. Actually the significance of arboreta in tree improvement ranges far beyond the contribution which they make in facilitating species crossing. Arboreta furnish many of the clues which lead to fruitful provenance studies. They provide material from which selections may be made with a view to developing definite types. If supplemented by "tree shows" as suggested by Syrach-Larsen, they help us to evaluate the effectiveness of our selections. Budget-minded folk tend to regard arboreta as expensive luxuries. Properly installed and cared for, they are expensive; they can be considered luxuries only if they are not used.

Now to attempt to forecast the future. Hybridization may be used to shed light on the relationships between species. Gaining this knowledge would be sufficient incentive to some of us, but we may expect other returns. So far I have mentioned only the potential values of first generation hybrids and their immediate progenies. While it is true that F_1 hybrids may offer valuable new combinations of characters, plant breeders have found that, by using hybrids for further breeding, they uncover entirely new combinations. In some cases the variety of these combinations, in a fairly small population of hybrid derivatives, is much wider than the variation in very large samples of natural populations of the parent species. Therefore, plant breeders find that the search for favorable combinations is more effective when their material consists of progenies derived from hybrids than when they start from so-called pure species. Complex hybrids, numbering three or more species in their pedigrees, may yield even more variable progenies. In the last few years geneticists and evolutionists, particularly Anderson and Stebbins, have resumed the study of hybridization as a major factor in plant evolution. If their views are correct it is likely that some of the bizarre and less promising hybrids we are producing today may be the progenitors of extremely valuable types. A less speculative value of species hybrids is the light they promise to shed on such problems as host specificity of certain insects. Studies by the Bureau of Entomology and Plant Quarantine in progress at the Institute of Forest Genetics are attempting to correlate oleoresin composition of Jeffrey-ponderosa pine hybrids with their apparent resistance to the bark beetle enemies of both parent species.

Polyploidy — in simplest terms the multiplication of the normal chromosome number of a plant—has for some years held the fancy of people concerned with tree improvement. In certain genera, notably Populus, polyploids have themselves been of some value. The hybrid horsechestnut, *Aesculus carnea* is a successful polyploid of particular interest because it is a member of that interesting class of polyploids, the true-breeding amphidiploid hybrids. Much interest in polyploidy in forest trees stems from the possibility that good hybrid combinations may be "fixed" or made true-breeding by polyploidy. To date, there has been little success in developing well-formed, normally growing polyploids in any of the principal commercial timber species of the world. On the other hand, many interesting bizarre and slow-growing freaks have been produced by treating seed, pollen, and vegetative shoots with such doubling agents as colchicine, heat, cold, and various radiations. Polyploidy somewhat resembles species hybridization as a factor in evolution; the offspring of polyploids may exhibit entirely new gene combinations. However, at least among forest trees, the prospects for immediate and direct use of polyploids seem somewhat more limited than is the case with species hybrids.

To return to the objective—the genetically improved forest. Species hybridization will be most effective in helping to achieve this objective if it is used as one of several techniques in a coordinated program. I suggest that the role of hybridization is to gain ground by creating new gene combinations. Other methods must be used to hold and exploit these gains.

Extensive Application of Genetics by the Silviculturist[1]

Clemens M. Kaufman
Director, School of Forestry, University of Florida, Gainesville.

MUCH of our forest land has been cut over, some areas several times, with the expediency of the moment guiding the manner in which the cut was made. That the destructive practices used have resulted in extensive deterioration of stand quality and composition is common knowledge. That dysgenic effects are an integral part of this deterioration is very probable.

Foresters, advocating good silviculture, have brought about a marked change in cutting practices and stand management. A number of companies and individuals have practiced good silviculture for thirty years or more, and within the last ten to fifteen years many private landowners have accepted the principles as a means of growing timber crops. Even so, we are still in what might be termed the fire protection-planting stage of forestry practice. Intensive application of the principles of good silviculture generally is still a goal for the future.

As we increase the breadth and intensity of silvicultural application the total effect can be materially improved by using the principles of genetics as one of the working tools. To do so, we need to recognize that environmental effects are governed by the genetic composition of the individual tree and that because of genetic variation we have races and strains and differences between individuals of the same species within a stand.

Extensive application of the principles of genetics in silviculture is possible: (1) When handling natural or planted stands for natural regeneration. (2) When collecting seed for artificial regeneration. (3) When cultural operations are carried out in current stands.

[1]Paper presented as part of panel discussion on Forest Genetics before the Division of Silviculture, annual meeting, Society of American Foresters, Colorado Springs, Colo., September, 1953.

Natural Regeneration

Good forestry emphasizes leaving the selected better trees for the final crop. These better trees will supply the seed necessary to regenerate the stand. The less desirable trees are removed in thinnings, improvement cuts and other intermediate operations. Recommendations concerning natural reproduction call for leaving the best trees as sources of seed; although, admittedly, we have a marked reluctance to leave the highest quality timber in the stand at the mercy of wind and lightning.

In order that some standardization of tree quality may be obtained, tree classifications have been developed by Dunning (*2*) and Wilson (*12*) for Douglas-fir; Taylor (*11*) for lodgepole pine; and by Gevorkiantz, et al. (*4*) for several Lake States species. These classifications are based on various combinations of age, vigor, crown quality, or soundness. Keen (*6*) proposed a classification for ponderosa pine, based on his findings that lower susceptibility to insect attack was related to tree vigor and health. The timber marker, in applying his art, can use these classifications to temper his judgment and experience.

Many of the factors which singly or in combination are used by foresters to identify crop trees and seed trees are known to be genotypic and to vary within species. Among these are vigor, crown and stem form, amount of natural pruning, resistance to diseases and pests, and wood quality (*1, 9*). Environment has a marked influence on these factors also. Difficulty arises when efforts are made to separate one kind of influence from the other.

Foresters have been trained to evaluate differences environmentally. As pointed out by Schreiner (*9*), Snow and Duffield (*10*), and Dorman (*1*), criteria for recognizing genotypic qualities must be established before we can be confident that we are selecting good genotypes. Snow and Duffield state ". . . when the forester is faced with specific problems of selection involving the recognition of inherent characteristics such as branchiness and tree form, abundance of seeds, cold and drought resistance, he can no longer apply general biological principles but must know something of the facts concerning mode of inheritance. If the mode of inheritance of desirable characters is known, then mass selection in existing stands will be possible." They warn that foresters must be conservative concerning the effects of environmental factors on the outward expression of excellence in seed trees.

Being conservative does not imply that we give up and do nothing. Lindquist (*7*), in discussing tree improvement practices for Sweden, points out that superior qualities of a mother tree cannot be established except by careful tests of hereditary qualities. But, he states, we do have reason to believe that the really good genotypes are usually very rare among inferior phenotypes, usually uncommon among moderately good phenotypes, but occur in good number among the best phenotypes. We can construe this to apply regardless of site quality.

When marking timber for intermediate cutting, whatever the nature of the cut, the forester is restricted somewhat by spacing in the choice of trees to leave. However, he is constantly provided with opportunities to exercise judgment on the basis of vigor, quality, and freedom from disease or insects.

In any stand, there probably will be very few trees which would qualify as elite, defined by Lindquist for Scot's pine as having at least 50 percent more volume than the average of the three next biggest trees in immediate vicinity, balanced by proper quality, particularly slenderness of branching.

Such restrictiveness is of primary interest to the tree breeder. It should not discourage the forester who is marking for a regeneration cut into thinking that because there were no such trees in his stand the quality of the germ plasm he has remaining is necessarily of a low order.

Judgment is essential. More variation due to environmental influences is to be expected in natural than in planted stands and in mountainous or uneven topography where soil fertility or moisture conditions may vary within short distances. Intermediate cuts would tend to reduce variation due to environment and raise the average level of quality and vigor of the stand.

When seed trees are selected in mature timber, only 10 per acre, or fewer, will be needed, permitting a high degree of selection.

Seed Collection

Planting provides the opportunity for intensive application of tree improvement. With over 60,000,000 acres to be planted, nationwide, and sound economics demanding that much of our better land be clearcut and planted under intensive management, we have the opportunity to use improved races and strains. We must remember, however, that at this time we have neither super trees nor seed from trees of proven quality, or even stands of average quality or better, phenotypically, which have been selected to supply the quantity of seed required annually.

In spite of the terrific pressure to grow more seedlings, state nurseries in the South are making an effort to localize seed collection within the areas in which the seedlings will be planted (5). Considering that one state is growing 90 million seedlings this year and another, growing 50 million, is planning to expand nursery capacity to grow 125 million in the near future, we realize the magnitude of this undertaking. Attention to even the phenotypic quality of the trees and stands from which the seed is collected will be a giant stride toward tree improvement.

Many holders of large forest areas have nurseries, thus are in position to give detailed attention to source of seed, geographically, as well as to the quality of the mother tree. Custom growing of seedlings by state nurseries affords land owners the opportunity to give detailed attention to provenance of the seed used to supply their seedling requirements (8).

One pulp company in the South is selecting "plus stands" in its holdings to provide the yearly seed supply. Each year a stand of sufficient area is thinned to 15-25 trees per acre to stimulate seed production. The company's experience has been that at the end of the third growing season the reserved trees in this seed producing area can be logged and a bumper seed crop harvested (3).

Cultural Operations in Current Stands

Silvicultural practice has been based on environmental effects without regard for what Pauley has termed the genetic *range of reaction*. He has pointed out that some genotypic traits are loosely controlled, others more rigidly. In some species, loose control of self-pruning enables us to improve wood quality by judicious control of stand density. Width of the annual ring, and width of the sapwood are also known to react to a wide range of environmental conditions. For that reason the silviculturist can exercise rather extentive control over these characteristics. As our knowledge of tree genetics increases, we may expect to learn the total reaction range of these characteristics and how much can be accomplished silviculturally toward controlling wood density, fiber length, figure in wood, crown and stem form, and other traits of significance in tree growth and wood quality.

Research will demonstrate that some traits are rigidly controlled so that no silvicultural influence will be possible. If changes in such traits appear desirable we shall need to depend on the tree breeder to accomplish them.

The most startling results in tree improvement very probably will be gained as a result of intensive selection and hybridization. However, such intensive application of genetics is still a future goal. In the meantime, millions of acres will be planted with stock not improved in this manner. Also, such application is limited to stands which at least initially were planted. Three-fourths, or more, of our timberlands will continue to be regenerated naturally. In current plantings and stands regenerated naturally, application of genetics will depend on extensive measures applied by the silviculturist. The effectiveness of such application can be increased as our knowledge of genotypical characteristics increases, but definite beginnings are possible now.

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Selection in the Intensive Phase of Forest Tree Improvement[1]

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THE TOPIC of selection, along with the topic of hybridization, could lead to a rather warm discussion of the relative merits of what some geneticists term the selection and the hybridization approaches to forest tree improvement. My discussion of selection is not planned to start any such argument, however, since the "intensive" phase of tree improvement usually depends on both selection and hybridization. They are mutually dependent upon each other, and whether a problem is attacked primarily by selection or hybridization depends on the nature and objectives of the problem. Although I shall discuss selection and how this approach can be important to tree improvement, I am personally not a strict "Selectionist" and the genetics research program of the Texas Forest Service involves hybridization wherever it is appropriate.

There is no general agreement among geneticists as to what the word selection should mean in connection with tree improvement. Some give it a special meaning, such as a breeding method, while others use it in the broader sense to imply the choosing of a desired tree. Throughout this discussion I will use the word selection in the broader sense, and will use Schreiner's term of selective breeding when referring to a specific breeding method.

I propose here to discuss selection as applied to the intensive phase, rather than the extensive phase, of tree improvement.

Selections of Strains and Races

Many of the earliest studies in tree improvement were made primarily to determine the importance of seed source, or provenance. These studies have been very valuable and have progressed to such a degree that it is now possible to select distinct races or strains from many of the important tree species. This type of study is popular at the present time, and I would estimate that more than half of what might be called tree improvement studies today deal with geographic, altitudinal, and other factors that influence variation within a species. Such seed source tests can be undertaken not only by trained geneticists, but also by any individual with a basic knowledge of forestry and research. They are extremely valuable and serve as the basis for all tree improvement work.

The economic importance of many results obtained in seed source studies have impressed industrialists. For example, a few years ago most of the southern states obtained loblolly pine seed from the most available and cheapest source, regardless of biological factors. Now many organizations require some degree of control of source, and a few large companies today will reforest their lands only with seedlings grown from seed collected in the immediate vicinity. Until the present tests are completed, such companies are following the safest rule, namely, the use of local seed.

In some cases, seed source tests may ultimately show that non-local sources are best, but the final decision cannot be made until the test plantings have become of merchantable age. To illustrate, we have found in our share of the South-wide testing of loblolly pine, that seed collected in North Carolina produced seedlings much better than local Texas stock, both in the seedbed and at the middle of the second growing season. But only time will tell what will happen to the North Carolina stock when we have a period of severe climatic conditions, such as often occur in East Texas, or how susceptible it will be to rust, insects, ice, etc.

Selection of Individual Trees

Up to now we have been discussing selection of strains or races. A more intensive type of selection is to choose, from a large population, individual trees that have phenotypic characteristics particularly desirable for some special purpose. After such trees are selected, the first step is to determine if they are truly genetically superior for the desired character, i.e., whether they are genotypically superior.

Such a determination can be made several ways. One is to grow open pollinated seed of the phenotypically outstanding trees under uniform conditions and determine the manner in which the desired characters are inherited. The value of such one-parent progeny tests has been questioned, however, and some geneticists have come to the conclusion that they do not warrant the time expended on them. Others have found them fairly reliable.

The most reliable progeny test involves the growing of seedlings from control-pollinated seed of the selected trees. In this case the characters of both parents are known, and such two-parent tests, when made under uniform conditions, ordinarily give a much better evaluation of the genetic inheritance of the selected characters.

Another way of determining the genetic potential of selected trees is to reproduce them vegetatively, by grafting or rooting, and make clonal tests. Such tests enable one to assess a selected tree and to determine how this tree will grow under different or controlled conditions—in effect, to "retest" the tree in which we are interested. Vegetative propagation has also been proven to be a useful tool in other ways, such as speeding up flowering time; this results in a general speed-up of the overall program. Although for these reasons vegetative propagation is one of the most important tools of the

[1]Slightly modified text of paper presented as part of panel discussion on Forest Genetics before the Division of Silviculture, annual meeting S.A.F., Colorado Springs, Colo., September, 1953.

geneticist, yet is it often his "bugaboo" because cuttings from mature trees of many species of forest trees have not been rooted. Most of you are familiar with the extensive genetic work done on the genus Populus. Although this genus has flowering and other characteristics that make it particularly desirable to work with, one of the greatest inducements for undertaking such extensive tests has been the ease of vegetative propagation of all but a few species.

A Selective Breeding Project

Until now, I have been speaking in rather vague, general terms. To close this discussion on selection, I am going to use as an illustration a project which seems to typify intensive selection, or more accurately, selective breeding. To make it more understandable, I will digress briefly to give a little of the background for this work.

The Texas Forest Service has underway a project to determine the genetic control of specific gravity of the wood of loblolly pine. One objective is to determine the extent to which wood specific gravity of a tree is strictly controlled by its genetic makeup, regardless of environmental fluctuations. In other words, we would like to find out whether the specific gravity of a tree is determined mostly by where it is growing, or mostly by its genetic potential. The subject of wood density control is controversial. Some silviculturists feel they know the answer: it is all environmental. So far, our tests in East Texas have not confirmed this hypothesis. The reported strong correlation between wood density and such things as site quality, moisture, growth rate, crown size, and others have failed to hold within the range of growth rates in which we are interested. We are not alone in this opinion; a number of other investigators have arrived at the same results independently. Ultimately, if we find from our research that specific gravity has rigid enough genetic control, we should be able to produce different strains of loblolly pine having wood with low and high specific gravities, respectively.

The first step in this project was to screen trees roughly for extremes of wood density. Nearly 7,000 loblolly pines in East Texas were sampled and from these about 40 were chosen. These 40 were further tested, more accurately, and of the 40 final trees we have selected four trees with a low specific gravity (around .450) and four with a high specific gravity (around .660) on which to start work.

To determine the genetic potential of these trees, two tests will be made. Ideally, the first is to make clonal tests by rooted cuttings. However, since we cannot as yet successfully root cuttings from mature loblolly pines, we obtained a large number of scions from the eight selected trees and grafted them to as uniform stock as was obtainable. Some of the grafts were twins, i.e., a scion from a tree with low specific gravity and a scion from a tree with high specific gravity were both grafted on the same stock so a forked tree will result. Doing this very nearly equalizes environment and the specific gravity of wood produced by each scion should indicate the genetic potential of that scion.

The next step is to make progeny tests. Open pollinated seed have been collected from the selected trees and plans call for control-pollination of light with light, dense with light, and dense with dense. Progeny tests from these crosses, as well as from possible inter-species crosses, will also be made and should show how the density character is inherited.

As the progenies and clones become old enough for further testing, and assuming we find rigid enough genetic control, the best of the tested trees will be reserved, and strains of trees with high and low specific gravity can be built up.

As illustrated by the above, selective breeding usually entails first a rough selection, often a second more restrictive selection, and after tests of progeny and clones, a further selection. To capitalize on what has been isolated, a method of producing the desired strains in quantity, such as seed orchard establishment, must be worked out.

Conclusion

Selection is an important tool of the forest geneticist. By selection you cannot produce new individuals with new combinations of characters, such as can be obtained by hybridization. But you can choose from existing individuals those exhibiting the desired characters, and by working with these you can build up strains of trees exhibiting these evident characters. Most of our important species contain enough variation that such choice of desired characters is possible. Selection is important, whether it be a part of the extensive phase of tree improvement or of types used in studies of races or of individuals such as I have described, and in many cases selection must be undertaken before hybridization can be most effective. It is of great importance to point out that selection, at least of the less intensive types, is a genetic tool immediately available to the practicing silviculturist.

S.A.F. Consulting Foresters Directory to be Published

Persons and firms listed in the S.A.F. Consulting Foresters Directory, published in the January 1954 JOURNAL OF FORESTRY, have been requested by mail to approve, correct, or revise their listings for the new directory to be published in the January 1955 JOURNAL.

Members doing consulting forestry work and whose names have not previously appeared are invited to apply now for listing. They should provide complete information following the form used in the List of Consulting Foresters published in the January 1954 JOURNAL OF FORESTRY. Society membership is a prerequisite for listing. Consulting firms will be listed if one or more of the partners or employees are members of the Society.

November 1, 1954 is the last date on which listings will be accepted for publication in the January 1955 directory.

Opportunities in Disease and Insect Control Through Genetics[1]

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THE PRIMARY objectives of breeding studies are to find or to develop the best trees possible for the places where we wish to grow them. Insect or disease resistance sometimes may be a major consideration. Three objections occasionally have been raised against tree breeding (1) it rivals silviculture, (2) it requires too long a time, and (3) it is expensive.

Instead of rivaling silviculture, tree improvement is an adjunct to and supplements it. By cutting the best trees we leave only the less desirable ones to provide seed. This leads to degeneration. To reverse this process we need to (1) make selections of the best germ plasm that nature has provided, (2) preserve it in suitable plantings, (3) improve it by applying the modern breeding techniques, and (4) use it in reforestation.

The time does seem long if one plans for complex hybrids like those used with corn and if one thinks he must wait twenty years between generations. But this is not the case. Fortunately, a number of simple procedures are available. Among these the most important is vegetative propagation. By this means outstanding trees which have proved their worth can be multiplied and their germ plasm preserved. The techniques of rooting cuttings and of making grafts provide wonderful methods for speeding up the process and for increasing the stock. Thus, by top grafting into flowering trees we can often secure seed production in a relatively few years. Cost seems small indeed in comparison with that portion of the national economy which is dependent upon trees. Only a short look ahead shows that doing this job is much cheaper than not doing it.

The idea of resistance to disease and insect damage is not new. The techniques and directions are well worked out with many agricultural crops. We are merely applying them to tree crops.

The basic procedures for breeding trees are relatively simple. They include:

1. The selection, propagation, and testing of local trees in relation to all the desirable characteristics, including resistance to disease and insects.

2. Similar critical examination of closely related trees wherever they may be growing. If trees are brought in from a distance suitable precautions are necessary to be sure that they carry no injurious insects or plant diseases. The elite trees, wherever obtained, should be preserved against loss in suitable arboretums, strategically located.

3. Further improvement by cross-pollinating trees with the best characteristics and by making thorough tests of the progeny.

By these procedures, we can combine the best and eliminate the worst features. Frequently some of the progeny may show unusual growth which is better than that of either parent. This is called hybrid vigor. Other means of inducing variations, such as treatments with colchicine, are available. Progeny testing is a continuing and necessary process because the seedlings from cross-pollination commonly show considerable variability. Only from the progeny can one estimate the genetic constitution of the parents and their general ability to combine with related trees. Utilization of these procedures gives promise of enabling the tree breeder, within reasonable limits, to grow trees to order in the same way that corn, wheat, and cabbage have been developed. In many cases, resistance is an essential item without which the trees fail to survive.

With this sketchy background, let us consider a few examples of some work done in developing trees resistant to insects or diseases. Against insects, the Jeffrey-Coulter pine hybrid is an outstanding example. J. M. Miller has shown that it resists injury from the reproduction weevil by the abnormal production of resin ducts and by walling off necrotic areas. Much of the literature on insect resistance has been assembled by R. H. Painter and some of it is discussed by S. A. Graham. Sometimes a special form of resistance has appeared when actually the tree has escaped attack through lack of timing in insect and tree life cycles. But reliable examples are scarce of true insect resistance. However, from the observations reported, one can confidently expect much evidence in the future. To mention only one item, my colleagues and I, through casual observation, have seen striking differences in the way insects either have attacked or have passed by the leaves on members of various poplar clones.

Against fungi we have good examples. Some years ago a selection of redcedar resistant to the cedar-apple rust was made by the late Anthony Berg. We have tested Berg's selection and have made several others from native trees in Wisconsin. Under circumstances where ordinary redcedars carried hundreds of rust galls, these selections were almost entirely free from them. They can be used for wood and for game cover without ruining nearby apple orchards with rust.

Two serious diseases occur on elm trees, Dutch elm disease and phloem necrosis. Since both diseases overlap in several north central states, the complexity of the problem is enormously increased. Thanks to Roger U. Swingle and his associates, much progress toward resistance has been made. Swingle has some European elm trees that are resistant to Dutch elm disease and many American elms that are resistant to phloem necrosis. Now he is searching for trees with resistance to both of these diseases.

The lovely ornamental mimosa trees used extensively in the south-

[1]Paper presented as part of panel discussion on Forest Genetics before the Division of Silviculture, annual meeting, Society of American Foresters, Colorado Springs, Colo., September, 1953.

east have been attacked in recent years by a Fusarium wilt which has been devastating in some locations. G. H. Hepting and his associates have made selections that show great resistance. The trees selected were survivors of both natural and artificial epidemics. They have been severely tested in soil where the causal fungus was abundant. The best selections have been propagated by cuttings.

The American chestnuts were attacked some years ago by chestnut blight and were wiped out, except for occasional trees on the fringes of the natural range that have escaped infection. The late Dr. Beattie collected seeds from a number of selections in eastern Asia and brought them to this country. The breeding work has been carried forward by A. H. Graves, G. F. Gravatt, and R. B. Clapper. Already resistant chestnut trees are growing well. Such trees will doubtless place the nuts back on the American market. The development of a forest type of tree with satisfactory resistance, however, seems to be more difficult, although not hopeless.

In Wisconsin some years ago, in association with T. F. Kouba and W. H. Brener, we made selections of over 150 trees which had withstood for fifteen years exposure to the white pine blister rust fungus. Wind-pollinated seeds were collected from these trees and grafts were made. These were planted with replications in a disease nursery near Wisconsin Rapids with an interplanting of Ribes bushes. Half the trees were given further and severe artificial inoculation. About three dozen of the original selections have shown a high degree of resistance. Unfortunately, the open-pollinated seedlings from these same trees carried little or no more resistance than commercial seedlings. For the present, the best means of propagation has been with grafts and much progress has been made recently with cuttings. J. E. Thomas and R. F. Patton have carried out various phases of this work. More or less parallel work has been done by R. R. Hirt at Syracuse, N. Y., C. Heimburger at Maple, Ontario, and R. T. Bingham at Spokane, Wash. We have great hopes for some of the crosses Bingham has made between some of our selections of resistant eastern and his selections of western white pine.

The specter of a new race of rust sometimes comes up. When it appears because an analogy has been made with the way new races of wheat rust develop, we must keep the analogy straight. The wheat plants correspond to the Ribes bushes and the white pine trees correspond to the barberry bushes. Thus one should look for any new blister rust races on the Ribes bushes. Too much time would be required to discuss this further. Meantime, we are not afraid of new races.

Poplar trees are increasing in importance. Unfortunately, the native trembling and large-toothed aspens in Wisconsin are susceptible to Hypoxylon canker. Furthermore, hybrid poplars with foreign parentage when grown in Wisconsin, have been attacked severely by a different canker. However, relatively resistant poplars seem to be near. With a little time R. G. Hitt, J. E. Kuntz, Keith Shea, and I think we can combine resistance and many desirable characteristics into a few individuals. It need not take too long, as breeding problems go. Using poplars and vegetative propagation we should need little, if any, handicap in a race with a wheat or corn breeder.

The ease with which these poplars are crossed is surprising, in view of the difficulty usually associated with tree breeding. Branches about five feet long with flower buds are cut in February or March in Wisconsin from both male and female trees, respectively. The lower ends are placed in a jar of water in a room where the air is about 70° F. and is reasonably humid. The staminate catkins come out in a week or two and shed pollen. This is collected and dusted on the pistillate catkins. In about two weeks they develop seeds, which germinate promptly. Seedlings six feet tall in one Wisconsin growing season are common.

We have over 400 selected clones that were rooted from cuttings. We are now testing some 4,000 seedlings. Vegetative propagation will help enormously not only to increase the best stocks, but also to keep constant their important characteristics. Already differences between clones for resistance to fungi and probably to leaf-chewing insects are appearing. Resistance to canker (and, we hope, to borers) shows on some older trees.

Possibly you will think we are placing too much emphasis on disease and insect resistance and not enough on quality. We have no such intention. But two basic ideas appear: (1) we must have such resistance to secure trees, and (2) modern technology, as we have seen it at the Forest Products Laboratory, does wonders with the raw material at hand.

In a discussion of tree breeding, a word of caution is necessary about assembling valuable trees from a distance. Chestnut blight, white pine blister rust, Dutch elm disease, gypsy moth, brown tail moth, and many other injurious diseases and insects have been imported inadvertently. Others occur abroad that might be equally destructive. Precautions against bringing them in are imperative. Planting seeds of our important trees abroad to determine their responses to various insects and diseases would permit additional important evaluation.

In conclusion, then, great possibilities are present for developing trees not only that are resistant to important insects and diseases, but also that have other desirable characteristics. Although only a few men are working on these problems, enough progress has already been made to indicate a bright future for further work in this field.

The Relation of Geographic Race to Forest Tree Improvement

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THE ARTICLES resulting from the Colorado Springs panel discussion of forest genetics include several references to geographic races and to seed-source or provenance studies. Pauley mentions the morphological or physiological diversity of genotype frequently found in species occupying wide geographic ranges or highly varied local habitats. He and Zobel emphasize the importance of seed source in obtaining seed for forest plantations. Duffield states that the performance of species hybrids is greatly influenced by the racial origin of the parents, and concludes that "the species hybridizer cannot escape the provenance problem."

These statements give a somewhat fragmentary picture of the relation of geographic races, geographic sources of seed, and seed-provenance studies to the science of genetics, to general silviculture, to forest planting, and to the possibilities of improving forest trees. The following may make the picture more complete:

1. The appropriateness of racial variation and of geographic sources of seed as subjects of genetics research can hardly be questioned. The physiological and other characteristics which distinguish any given geographic race, and which render it well adapted to one general environment and poorly adapted to another, are controlled more strongly by genetic make-up than by cultural or other external influences. The frost-hardiness and drought-hardiness, and often the disease-resistance, of trees in any particular place depend more upon their ancestry than upon the species associated with them in the stand or the spacing at which they are planted.

2. Except in connection with planting, the silviculturist is little concerned with geographic races and seed provenance. Natural reproduction from indigenous old or second-growth stands is, as a rule, genetically well adapted to the site on which it occurs. To the planter, however, geographic race and source of seed are of paramount importance. Many decades of experience in all major forest regions of the world have shown that stock of the wrong geographic race may greatly reduce the success of planting, or cause complete failure.

3. Although the characteristics of geographic races are in the main genetically controlled, and the techniques of studying them are those required for any progeny tests, most provenance studies have been undertaken for the immediate practical purpose of finding sources of seed that will produce stock adapted to particular localities. Unlike the selection and hybridizing studies discussed by Pauley, Zobel, and Duffield, such provenance studies have not ordinarily included effective steps to isolate new and better gene combinations *within* geographic races. They have simply attempted to provide, for given planting sites and localities, gene combinations as good as those which, under happier circumstances, might have appeared in natural reproduction on the same sites. Strictly speaking, they have not been attempts to improve trees, but merely to preserve the *status quo* in terms of hardiness, growth rate, and the like.

4. Theoretically, the distinguishing of geographic races may contribute to tree improvement in a manner more positive than that just described. It is possible that hybrids between geographic races within a species may be adapted to a wider range of environments than either parent race. In some instances they may exhibit hybrid vigor as well. Although these possibilities have been little explored as yet, particularly with American species, they furnish a real incentive for learning the existence and distribution of geographic races.

5. More important still, the existence of markedly different geographic races within a species may impose rather strict limits upon selection and breeding within that species. It is very likely, for example, that the best gene combination for growth rate, branch habit, and so on that could be isolated among loblolly pines in Maryland would be less successful in Texas than the average Texas loblolly, because of poor adaptation of the parent Maryland race to Texas temperatures and, perhaps, to Texas day-length. Conversely, there is experimental evidence that the best selection of Texas loblolly would almost surely fail in Maryland for lack of cold-resistance. In other words, genetic differences between individuals or local strains within a geographic race, even though important in a locality to which the race is well adapted, seem likely to be overshadowed by the genetic unsuitability of the race as a whole when stock is transferred to a less favorable place. The inescapable conclusion is that selections and hybrids must be made separately, region by region, within the framework of existing geographic races. To the extent that this is true, provenance studies designed to identify such races and define their territorial boundaries are fundamental to other phases of tree improvement.

Seed Certification and Forest Genetics

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CERTIFICATION or approval by some official or semi-official testing agency is commonplace with many manufactured articles, but nowhere is this warranty more firmly established than with biologicals and medicines. Origin and quality of living organisms have long been the object of certification in livestock and more recently in agricultural seeds. The status of certification of forest tree seeds was summarized by the writer (*6*) and in an article in *Forestry Abstracts* (*1*); to these the reader is referred for details.

During the 15 years since these papers appeared enough progress has been made in authentication of origin and quality so that the purchaser of tree seeds can, if he so wishes, obtain some information on the place where the seeds were collected, and often on purity and germination. Unfortunately, however, there is still little demand by the American consumer for certification, and even less interest by the planter in the source of the seed from which his nursery stock was raised (*9*).

The Seed Policy Committee of the U. S. Department of Agriculture transmitted to the Secretary early in 1939 a statement of Forest Seed Policy drawn up by the Forest Service and Soil Conservation Service. This was duly approved by the chiefs of each service and by the Secretary. This established a policy for the department that included among other provitions the following:

1. To use only seed of known locality and nursery stock from such seed.

2. To require of the vendor evidence verifying the origin of all seed and nursery stock.

3. To keep records of the origin of all lots of seed and nursery stock.

4. To use local seed from natural stands wherever available unless seed from another specific source has been demonstrated to be satisfactory.

5. To urge states and other agencies engaged in planting, the expense of which is borne wholly or partly by the federal government to adhere to this policy.

On the same day that the chief of the Forest Service approved this policy, New York passed a state law requiring all tree and shrub seeds sold in the state to be labelled, showing the purity, germination and specific locality of origin. (Chapter 527) (Amendment to Article 9, Section 140-b) (*10*). Some years later Georgia passed a similar law and regulations regarding southern pines. A digest of all state seed laws is given in the Seed Trade Buyers Guide (*5*).

The Federal Seed Act of 1939 (*3*) laid down elaborate requirements for evidence of origin and seed quality for certain agricultural seeds but did not include tree seeds. It is the unofficial opinion, however, that only a policy decision at the bureau level is needed to bring tree seeds under these provisions.

Meanwhile many U. S. seed dealers, following the practice of European dealers, voluntarily began to offer origin data and to some extent reports of purity and germination, chiefly in response to a demand for such information by foreign purchasers. Among the first was Brown Company, Berlin, New Hampshire, in 1929. The Manning Seed Company is now an outstanding example.

On the international level the FAO of the United Nations has made seed certification an important part of its agenda (*4*) and in 1952 adopted a standard form for certification of both origin and quality.

Developments in seed certification outlined above have perhaps over-emphasized legal restrictions and regulations. Experience has shown that with most species even official testing stations can enforce no requirements except trueness to name, purity, and germination (*8*). The integrity of the collector and the care with which different origins are kept separate at all stages of seed collection and handling must be our main reliance. Intelligent self-interest on the part of both the collector and the consumer of tree seeds will gradually bring about better records on the source of seeds and the trees grown from them.

Perhaps we have been overzealous about official certification and have imagined that once laws are passed and everything had a "certified" label on it, all our forestry problems would be gone. We have gone for certification without always analyzing what it means.

A short time ago, for example, I received a sample of larch seed from Japan accompanied by a "phytosanitary certificate." This certified that the seeds were free of insects and disease. Our own quarantine inspection stations inspect and treat seeds and issue similar certificates. No one questions the necessity for such certification to prevent spread of disease and insects.

Why not also have certification to prevent the spread of inferior genetic stocks of trees? For one thing, neither the purchaser nor the dealer seems concerned enough to demand it. Even if they did, however, there is far less basis for inspection. The seeds are, we shall say, collected from certified stands of straight, healthy trees, but we can certify the seeds only, not the progeny. Concealed in the straight stems of the parents are unfavorable genes, or the trees are not frost-hardy or are a prey to insects in their new home. How can any quarantine certify to the suitability of seed even when the planting site is known? We are forced to conclude that certification is of most value with regard to purity, germination and freedom from insects and diseases, can offer less easily verified warranty on the geographic source, and may be meaningless so far as vigor and form of the progeny are concerned.

Provenance tests, in which trees of the same species from different

geographic origins were planted side by side, first focused attention on the existence of racial differences and the need for care in selection of origin. Such tests continue to serve forest genetics well in providing proof of variation in tree populations and material for selection and hybridization.

The reason for certification of origin is, of course, the variation of geographic races proven for some species, and other suspected variations in genotype. (Cf. Table 2, Page 16-17, Woody Plant Seed Manual [2].) As a basis for tree improvement the geneticist wants stock of known geographic race. A certified origin usually embraces a fairly wide area such as several square miles but varying only slightly in altitude. Often it is desirable to have a seed lot obtained from a number of mother trees. It should be obtained from natural indigenous stands; if from planted stands, they should be raised from local seed, otherwise certification has little meaning.

Obviously the certification of origin as commonly practiced leaves much to be desired for some experimental work. Yet even controlled pollination of selected mother trees might not result in better progeny. More important may be seed collection in natural virgin stands, where these exist, so that the population produced from the seed will contain representatives of all natural variants in the native stand. Then the best elements could be selected and propagated.

Practical certification can vouch for the physical environment in which the seed was collected and for the natural reproduction of the parent stand from indigenous stock. Once a plantation of known seed origin has been established, information about its source permits further collection of seed of the same source if the results are good, or avoidance of this source if the plantation has turned out badly.

The interaction of the genotype with the environment gives continually new material for selection, natural or man-influenced. Repeated tests of the same origin on the same site may be necessary to prove beyond doubt that the behavior of a certain origin is consistent. The results may be applicable only on the site or locality where the plantation is made. Certification, however arrived at, is essential to such testing and to many phases of controlled selection for tree improvement. Certification is after all largely a human problem, subject to all the complexities of human psychology, sociology, economics and politics. Genetics is fortunate in having only the plant and environment to consider.

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The Cover Photo. District Forester Hoover of the International Paper Company relates: "The land on which the tree is located originally belonged to the Denkmann Lumber Company. This company, when it was in operation, received an order for 125 foot piling and, after considerable search, located a stand of sufficient height on their own land. One of the workers who helped in the cutting reports that some of the trees would have made longer piling but were cut back to 125 feet. The tree in the photograph is the only remaining tree in the group. It is 125 feet tall, 25 inches in diameter and is approximately 68 years old. It has 79 feet of clean stem and contains six 16-foot logs or a 100-foot piling. This site is located about one mile from the Pearl River. However, nowhere else along the river in this area have the trees attained such heights. This would indicate a possibility of a race of tall growing trees of good form."

Breeding for Improved Growth Rate and Timber Quality in Western White Pine

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A cooperative project designed to breed blister-rust resistant and otherwise superior western white pine is now in its fifth year of activity. This report goes into detail on phases involving intraspecies breeding for improved growth rate and timber quality. It describes the work being done and presents some early results. Growth rates of numerous progenies produced by controlled pollinations were statistically correlated with growth rates of their parents. Thus, experimental control was more complete than in many previous investigations on heritable vigor.

PRELIMINARY results of a breeding project in western white pine (*Pinus monticola* Dougl.) show promise for improving growth rate and timber quality. The work is part of a project designed to develop white pine which is not only resistant to blister rust (*Cronartium ribicola* Fischer) but fast growing and of high quality (*1*). Although the entire project entails both interspecies and intraspecies breeding, this paper deals only with the latter. The study has not been completed but techniques developed and results obtained during the past 4½ years may be useful to others engaged in similar work.

In the attempt to improve growth rate and timber quality selected trees are being controlled-pollinated and grafted. Growth rate and crown form in parent trees, progenies, and clones are being measured in detail. When progenies and clone members become of sufficient age to permit reliable comparisons of growth rate and timber quality the parents will be rated for superiority of these traits. The best parents, provided they possess a useful degree of resistance to blister rust, will be vegetatively propagated for use in seed orchards.

In carrying out the work, possibilities for estimating inherent growth and crown form superiority through measurements of outward (phenotypic) characteristics are also being investigated. Development of such techniques would permit screening from a larger population with a minimum of progeny testing, and thus would improve the efficiency of an enlarged selection program.

Controlled Pollinations

Between 1950 and 1952 intraspecific controlled pollinations were made among trees selected for apparent resistance to blister rust and 151 of them produced sound seed in sufficient quantities for progeny testing. An additional 91 crosses were attempted in 1953, but whether or not they will yield sound seed will not be known until the fall of 1954. The crosses involved 46 parent trees growing in 9 separate selection areas within northern Idaho and western Montana.

Most of the pollinations were made on five "test" trees. These test trees were chosen from the resistant selections mainly on the basis of their fruiting ability. As many of the remaining trees as possible were used as pollen parents on the test trees, or vice versa. This scheme will facilitate rating of the parent trees for heritable traits, permitting logical comparisons among crosses having a common parent.

Progeny Testing

Seeds produced from 71 cross-pollinations, 6 self-pollinations, and 17 wind-pollinations were sown in a nursery at Spokane, Washington, in 1952. Seeds from 19 cross-, 2 self-, and 10 wind-pollinations were sown in the same nursery in 1953. Seeds from the same origin as half of the lots sown at Spokane in 1952 were also sown in the Montana State University forest nursery at Missoula, Montana. Additional seedling progenies will be grown as seeds from pollinations made in 1952 and 1953 become available. Progenies will be outplanted in three plantations designed solely for testing growth rate and timber quality as well as in three rust-resistance test plantations.

Average seed weight of each lot was measured before sowing and germination counts were taken following sowing. Average seedling heights were measured at the end of each growing season (measurements were made on from 10 to 90 seedlings for each lot, depending upon the number available; most lots contained from 60 to 90 seedlings each). Average branch lengths were obtained on about 10 percent of the seedlings grown in 1952, at the end of the second season. Growth rate and crown form will be measured periodically.

Clone Testing

Thirty-six of the parent trees were grafted in large numbers and the clones were outplanted in five localities. Average height growth and average branch lengths, based on 3 to 12 members in each clone were measured on each of 28 of these clones when 3 years of age. Similar measurements will be made periodically.

Measurement of Parent Trees

A special measurement technique was devised to obtain quantitative expressions useful in studying inheritance of vigor-quality traits and in investigating possibilities for predicting progeny performance. The method was designed to circumvent, insofar as possible, differences caused by environment, which may mask the inherent potentialities. Furthermore, it was

[1]The authors are grateful to Dr. F. I. Righter, California Forest and Range Experiment Station and Dr. J. W. Duffield, University of Washington, for their technical advice and assistance given in breeding work and for their review of the manuscript.

desired that expressions be nonsubjective in order that they could be used both in comparing large numbers of individual trees and in seeking statistical correlations with progenies. For example, specific measurement data expressing crown width are more useful than attempting to classify each tree as being narrow-, normal-, or wide-crowned.

Measurements were taken on 108 check trees as well as 40 parent trees used in breeding and grafting. Three and occasionally two non-resistant check trees of similar age and growing condition were chosen in the vicinity of each parent selection.

The following measurements were taken:

1. Diameter at breast height.
2. Age.
3. Total height.
4. Total height growth during the last 10 years, excluding current growth (1943-1952 inclusive).
5. Stem diameter outside bark, at a point 4 inches above the 10th (1943) whorl from top of tree, current year's whorl excluded (whorls indicated in items 6 and 7 below were determined in the same manner).
6. Lengths of branches at the 9th, 10th, and 11th whorls.
7. Basal diameter of branches at the 9th, 10th, and 11th whorls, taken at a point 3 inches from the bole.

Most of the trees were free, or nearly free, of upper crown competition. Where upper crown competition occurred on one side, branch measurements on the opposite side only were used. It is possible that the occurrence of competition on one side of a tree may affect growth of those branches on the opposite side. However, greatly noticeable effects were not apparent on the trees measured and inaccuracy due to this cause is not believed to be great. Possibly this aspect of the measurement technique needs further study. Where noticeable upper crown competition was appreciable on all sides, the trees were not measured.

The trees varied in age from 20 to 60 years. The method may not be satisfactory on trees where growth in the upper crown has decreased appreciably or ceased (probably trees over 100 years old).

Height growth, stem diameter, and branch dimensions were measured in the upper crown because crown competition there was usually less severe than in lower portions of the trees. In completely isolated trees measurements could have been taken throughout the crown with equally good or better results. However, current competition in the lower crown often was evident and past competition was difficult or impossible to assess. Measuring specific portions of the upper crown provided more comparable values than would have been obtained if measurements had been taken in the lower crown or at varying portions of different trees. Admittedly, past and present understory competition may have had some effect upon growth in the upper crown. Possibilities for adjusting for such effects are being investigated. For the present, measurements obtained on trees having heavy understory competition must be interpreted with caution.

The data formed the basis for evaluating certain traits. Average annual elongation during the last 10 years was used to express growth rate. Branch measurements were related to stem measurements and used to express crown form. For example, the ratio of the height of stem above the 10th whorl to the average branch length (computed from branches measured at the 9th, 10th, and 11th whorls) expressed relative branch vigor, or relative crown width. Similar ratios were computed for (1) diameter of stem at 10th whorl to average branch diameter at the 9th, 10th, and 11th whorls and (2) volume of stem above 10th whorl to average total cross sectional area of branches at 9th, 10th, and 11th whorls.

Average periodic annual elongation (average annual height growth during the last 10 years) was believed to be a more satisfactory measure of growth rate than mean annual elongation (average annual height growth during the whole life of the tree). All trees within selection areas were subjected for the most part during the last 10 years to the same climatic conditions. On the other hand, since the trees differed in age, they were not subjected to the same climatic conditions during their entire life, upon which mean annual growth is based. Results of the analysis of progeny-parent growth relationships, discussed later, tend to support the belief that average periodic annual elongation is superior to mean annual elongation.

Use of relative measures to express crown form were considered necessary to account for differences in actual measurements caused by extraneous effects and to permit fair comparisons. More rapidly growing trees in general tended to have longer branches (the correlation index between average branch length and average periodic annual elongation among the 148 trees was .61, highly significant). Apparently branch growth was, to a large degree, affected by some of the same factors of inheritance and site as was stem growth. In evaluating branch vigor the authors were interested in any inherent tendency of branches to grow rapidly or slowly in respect to stem growth. Therefore, effects of those factors of inheritance and site having a common effect upon stem and branch growth had to be circumvented. It is believed that the use of ratios did this effectively and one might estimate that efficiency was increased by about $(.61)^2 \times 100$, or about 37 percent, over the use of actual branch length alone. Undoubtedly, differences caused by such factors as winter injuries and upper crown competition (however light) were not accounted for by use of the scheme discussed. Actual efficiency of the method will eventually be tested when clones and progeny are of sufficient age to reveal possible correlations with parents.

Considerable variation in growth rate and crown form was found both within and between selection areas (Table 1, Fig. 1).

FIG. 1.—Variation in crown form. The tree on the left (stem height vs. branch length ratio, about 5) has considerably shorter branches relative to stem growth in the upper crown than the tree on the right (stem height vs. branch length ratio, about 2).

—Photos U. S. Dept. Agric.

Parent-Progeny Growth Relationships

Progenies of the same age but having different parental combinations varied greatly in total height (Figs. 2, 3, and 4). For example, 1-year-old progenies produced in 1952 varied from .099 to .193 foot in average height. Among 1-0 lots grown in 1953, average heights varied from .074 to .161 foot. Large differences found among seedling lots grown in 1952 persisted to the end of the 1953 season. Furthermore, lots that were tall at the end of the first season were in general the tallest after the second season—the correlation coefficient between average heights of seedlings at 1 and 2 years of age (using the same seed lots) was .91.

Average heights of progenies correlated significantly, though not strongly, with growth rate of parents (Table 2, Figs. 2 and 3). In determining the correlation indices the mean of the average periodic annual elongation of the two parents of each progeny was used as one variable and the average heights of 1- and 2-year-old progenies were used as the other variable. For wind-pollinated and selfed lots, the average periodic annual elongation of the single known parent was used. Several other points are worthy of mention:

1. The relationships found among 1-0 seedlings grown in 1952 remained about the same to the end of the 1953 growing season.

2. An adjustment of progeny heights for the effects of seed weight had variable effects upon the parent-progeny growth correlations. The correlation indices for cross- and self-pollinated lots grown in 1952 increased while the indices for the cross-pollinated lots grown in 1953 and wind-pollinated lots of both years decreased. The decrease among lots grown in 1953 was due largely to the fact that a preponderance of those progenies had slow-growing parents from White Rock, which produced relatively light seed and shorter progenies. Weather may also have had an effect on the progeny height-seed weight relationships.

3. Wind-pollinated lots revealed the weakest correlations. This was expected, because in seeds produced from wind-pollinations, only the seed parent is known.

4. Although correlation indices shown among lots resulting from selfing are nonsignificant, the values are relatively large. Additional data might have revealed significant relationships.

5. Correlations were stronger among lots grown in 1953 than those grown in 1952. The lots grown in 1953 contained progenies whose parents were located in five different selection areas, while only four selection areas were repre-

TABLE 1.—RANGE OF VARIATION IN STEM GROWTH AND EXPRESSIONS OF CROWN FORM IN 148 RESISTANT AND NONRESISTANT WESTERN WHITE PINES

Selection area[1]	Average periodic annual stem elongation	Stem height vs. branch length	Stem D.O.B. vs. average branch D.O.B.	Stem volume vs. av. total cross-sectional area of branches	Trees measured
	Feet	*Ratio*	*Ratio*	*Ratio*	*Number*
Crystal Creek	1.7-3.4	2.4-6.6	3.0-6.8	12-68	52
Middle Fork	1.1-2.4	2.4-4.2	3.8-5.5	11-44	15
Gold Center Creek	1.2-2.3	1.8-3.4	2.7-5.3	9-39	32
Elk Creek (Lower)	2.0-2.9	1.9-4.9	3.1-5.5	11-40	12
Elk Creek (Upper)	1.6-2.1	2.2-4.0	3.6-5.1	17-40	10
White Rock	0.7-1.6	1.6-3.2	2.7-4.4	4-19	16
Emerald Creek	1.3-2.1	1.9-3.7	3.0-5.4	9-37	11

[1]These areas are all in Idaho. Crystal Creek is in Benewah County; Middle Fork, Gold Center Creek, and White Rock are in Shoshone County; Lower Elk Creek and Upper Elk Creek are in Clearwater County, and Emerald Creek is in Latah County.

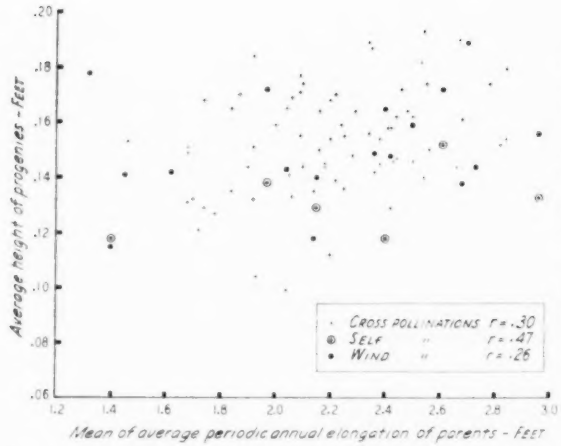

FIG. 2.—Scatter diagram of unadjusted average heights of 1-year-old progenies over mean of average periodic annual elongation of parents. Progenies grown in 1952.

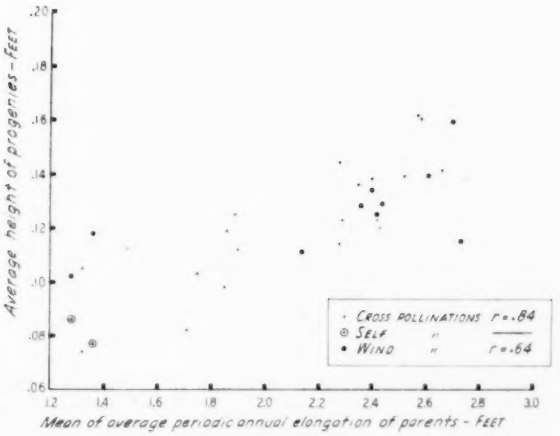

FIG. 3.—Scatter diagram of unadjusted average heights of 1-year-old progenies over mean of average periodic annual elongation of parents. Progenies grown in 1953.

sented in the 1952 lots. Inclusion of parents from more selection areas, notably the slow-growing trees at White Rock, enhanced the chances for a stronger correlation in the 1953 lots.

Average periodic annual elongation appeared to correlate better with average progeny height than did average annual elongation as shown by the correlation indices in the following tabulation:

	10 lots grown in 1952	10 lots grown in 1953
Using average periodic annual elongation:		
Cross-pollinations	.30	.84
Self-pollinations	.47	—
Wind-pollinations	.26	.64
Using average annual elongation:		
Cross-pollinations	.12	.80
Self-pollinations	.16	—
Wind-pollinations	.11	.60

Average heights of progenies (adjusted for seed weight) produced by parents crossed with test trees suggest that some parents tended to produce tall progenies rather consistently while others tended to produce shorter ones (Table 3). For example, progenies of tree number 18, were tall in comparison with other progenies having the same test tree parents. Wind-pollinated progenies of tree number 18 were likewise tall. Tree number 19 on the other hand rather consistently produced short progenies.

As is evident in Figures 2 and 3 and Table 3, selfing resulted in considerable dwarfing of progenies. These effects, along with other effects of selfing, are covered in a separate report being prepared by the authors (2).

It should be pointed out here that results are based upon progeny performance in the Spokane nursery only. Among the relatively few lots sown at Missoula, performance was rather similar to corresponding lots at Spokane. Different results possibly would have been obtained if the seedlings had been grown at several localities more representative of the total climatic conditions applicable to the western white pine type, or if nursery treatment had varied greatly. After the progenies are outplanted in the six test plantations, effects of planting site can then be appraised.

Correlations Involving Crown Form

Average relative crown width among 2-year-old progenies and the corresponding 3-year-old clones of their pollen parents correlated significantly at the 5-percent level (correlation index, .35). However, several other tests involving relative crown width among parents, clones, and progenies failed to reach statistical significance. Apparently it is too early to expect reliable indications of the heritability of traits involving crown form, but these preliminary results indicate that investigation may be

FIG. 4.—Variation in 1-year-old progeny heights. Seedlings of cross 19 x 37 (front row) averaged .104 foot in height while seedings of 37 x 17 (rear row) averaged .138 foot. Trees in the second and seventh plant bands from the label in the rear row, being replacements and consequently not currently comparable to the others, were not used in determining the average height.

more fruitful as crown development progresses.

Discussion

Just how much of the variation in average height among the 1- and 2-year-old progenies is inherent remains to be seen. The present differences that appear to be attributable to the different parents, are not considered reliable enough to justify rating the parent trees for inherent superiority in growth rate. Such ratings will of course be attempted when the progenies are older. However, the apparent tendency for faster-growing parents to produce taller progenies, though not strong, indicates that at least some of the present variation is inherent. There is promise here for future improvement in growth rate.

Whether or not one can make a preliminary estimate of inherent growth rate in the selected trees by phenotypic measurements alone, with any degree of accuracy, also remains to be seen. Here again, however, the progeny-parent growth relationships found in this study do give promise for making an estimate which could be useful. The use of average periodic annual elongation rather than average an-

TABLE 2.—CORRELATION INDICES BETWEEN AVERAGE HEIGHTS OF PROGENIES AND MEAN OF AVERAGE PERIODIC ANNUAL ELONGATION OF PARENTS

Item	Progenies grown in 1952			Progenies grown in 1953	
	1-0 seedlings	2-0 seedlings	Basis, lots	1-0 seedlings	Basis, lots
	Cor. index	*Cor. index*	*Number*	*Cor. index*	*Number*
Cross pollinations:					
Unadjusted	.30*	.29*	71	.84**	19
Adjusted for seed weight	.40**	(1)	71	.57*	19
Self pollinations:					
Unadjusted	.47	.52	6	(2)	2
Adjusted for seed weight	.58	(1)	6	(2)	2
Wind pollinations:					
Unadjusted	.26	.32	17	.64*	10
Adjusted for seed weight	.20	(1)	17	.22	10

[1]Undetermined
[2]Insufficient data to determine correlation index
*Significant at the 5-percent level
**Significant at the 1-percent level

TABLE 3.—AVERAGE HEIGHTS OF 1-YEAR-OLD PROGENIES, ADJUSTED FOR SEED WEIGHT, PRODUCED FROM CROSS-POLLINATIONS INVOLVING TEST TREES, SELF-POLLINATIONS, AND WIND-POLLINATIONS, AND PARENTAL GROWTH RATES. PROGENIES GROWN IN 1952 AND 1953.[1]

Location and number of parent tree	Average height of progenies when crossed with test tree number:					Average height of self-pollinated progenies	Average height of wind-pollinated progenies	Average periodic annual elongation of parent
	19	20	30	58	59			
	Feet							
Crystal Creek								
10	.115	.144						2.35
15			.162				.162	2.50
16	.135	.169	.155	.162			.134	2.04
17	.132		.153	.166	.111*		[2].111	2.73
18	.142		.195	.183	.146*		[2].195	2.70
19		.132	.117	.131		.109	.125	2.15
20	.132		.143	.160	.117*	.117	[2].163	2.40
21	.119		.154	.177	.132*		[2].131	2.14
22	.131	.161	.170	.171	.148*	.156	[2].176	2.61
24	.113	.140		.156			.136	2.68
25			.159	.151	.117*		[2].148	2.36
27		.161					.151	2.42
45	.131				.155*			2.26
58	.131	.160	.171			.133	.159	2.96
Middle Fork								
1	.116	.140	.145					1.70
28	.152						.185	1.32
29	.133			.175				1.22
30	.117	.143		.171		.124	.163	1.97
Gobl Center Cr.								
23							.138	1.45
34	.135							1.20
35							.133	1.62
37	.088		.120	.152				1.71
39	.120	.143	.127	.149		.114	.111	1.40
Elk Creek (Lower)								
59		.117*					.136*	2.44
62					.120*		.135*	2.42
White Rock								
54					.126*	.082*	.130*	1.36
63					.125*	.095*	.111*	1.28
Emerald Cr.								
38	.121							1.28

[1]Progenies grown in 1953 are indicated by an asterisk*.
[2]Also grown in 1953 from the same seed lots used in 1952. Average heights for each of the indicated parents, obtained in the latter year, are as follows: 17, .085; 18, .166; 20, .132; 21, .124; 22, .144; 25, .129. They were shorter than those grown in 1952, possibly because of seed deterioration or effects of season or both.

nual elongation appears to be a step in the right direction. Possibilities for adjusting phenotypic measurements for those effects of environment that are associated with selection areas are being investigated. The relative cost of phenotypic measurements as opposed to progeny testing certainly justifies further investigation. Practical techniques for estimating inherent vigor through phenotypic measurements would minimize the amount of progeny testing necessary and permit selection among a greater population.

The scheme used for measuring other phenotypic traits has merit, though its degree of usefulness will not be known until grafted trees and progenies are older. It was found practicable on relatively open-grown, young trees. Future growth of progenies and clones may disclose the need for modifications. In the meantime, the method does provide specific values, uniformly obtained on all trees measured, which can tentatively be used in studying heritability.

Summary

Techniques and early results of intraspecies breeding for improved growth rate and timber quality in western white pine are discussed in this paper. Forty apparently resistant and 108 nonresistant check trees were measured according to a specially designed technique. Forty-six rust-resistant trees were used in cross-pollination and about 36 of them were grafted in numbers. One- and 2-year-old progenies from 125 cross-, self-, and wind-pollinations have been studied to date. Seedling progenies and 3-year-old grafted trees were measured in detail.

Early results revealed considerable variation in average progeny heights. Just how much of the variation is inherent remains to be seen. Some of it was associated with parental growth rate as shown by statistically significant, though not strong, progeny-parent growth correlations. The results open up possibilities of improving growth rate by the method outlined. Average annual height growth during the last 10 years appeared to be a better measure of growth rate for studying heritability than did average annual height growth during the whole life of the tree, in the relatively young trees measured.

The scheme used for measuring phenotypic traits proved practical and provided specific values, uniformly obtained on all trees, which are tentatively being used in studying heritability. Further revision may become necessary as more reliable information is obtained from further development of progeny tests.

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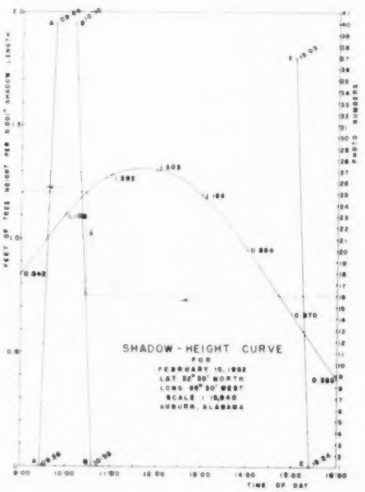
Correction

In the article by Evert W. Johnson, "'Shadow-Height' Computations Made Easy" (Jour. Forestry 52:438-442) appearing in the June issue, Figure 4.—Shadow-length-tree-height ratio curves, was inadvertently cropped at the bottom, resulting in loss of the abscissa. It is here reproduced, uncropped, with the JOURNAL'S apologies to the author.



Wood Density and Seed Source in Young Plantation Red Pine[1]

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IMPROVED STRAINS of tree species may contribute much to forestry in the future. Some objectives to be sought in developing improved strains might include: increased growth, shorter rotations, ease of silvicultural management, increased disease and insect resistance, improved form and quality of wood for certain products, and increased density of wood or more wood substance per unit of volume. The latter would be equivalent to a shorter rotation and reduced costs per unit of volume. All these factors could influence favorably the economics of tree-crop production.

On the other hand, to perpetuate new strains, tree-seed orchards and artificial reproduction will be necessary. Therefore, the inherent advantages of the new strain plus any advantages that might result from artificial reproduction in the future will have to more than offset the added cost of its introduction and establishment.

This investigation is an attempt to determine whether or not strains differing in wood density exist within the red pine (*Pinus resinosa* Ait.) species. It is part of a larger cooperative genetics project with the Lake States Forest Experiment Station to discover and to develop improved strains within the species.

Materials and Methods

1. *Field Methods.* — Red pine seed was collected by the Lake States Forest Experiment Station from many localities in the United States and Canada. From these seeds, 2-1 planting stock was raised in the nursery and field planted in 1937 at a 4- by 4-foot spacing under similar site conditions on a good loamy-fine sand on the Chippewa National Forest. The plot was thoroughly cultivated and to insure further statistical equalization of site, the trees from different localities were planted in randomized rows with more than one row allotted to most seed sources.

For this specific-gravity study, subsamples of wood from red pines grown from seed produced in 19 localities were taken to include, in so far as possible, a representative sample from both the East and Midwest as follows: Minnesota 5, Wisconsin 7, Michigan 2, a combined sample from Wisconsin and Michigan, and one sample each from Maine, New York, Pennsylvania and Ontario.

The plot was thinned during February and March 1951, 17 years after the seed was planted in the nursery. Wherever possible, alternate trees, regardless of crown class, were removed to maintain uniform spacing or stand density and to prevent introduction of bias into locality data at later remeasurements.

From this systematic sample, a random sample of ten trees for each locality, or a total of 190 trees, was obtained for this study. Since the distribution of volume and therefore specific gravity should be independent of position in a row, this systematic-random sample has been considered as equivalent to a random sample.

The following data were obtained for each tree: d.b.h., total height, and tree class according to the Lake States Tree Classification of Gevorkiantz, Rudolf, and Zehngraff (*1*). In addition, a two-inch specific gravity disk was cut from each tree at 82 inches above the ground. This height was used so the bolts could be utilized by the fence-post plant at Cass Lake, Minnesota. This point also has the advantage that the specific gravity computed for this height probably is more representative of the average specific gravity of the tree than a value obtained from breast height, because it is more nearly the center of volume for most of these trees.

These disks, labelled with locality, row number, position in the row, and tree number were shipped immediately to St. Paul and kept moist by proper storage in order to prevent shrinkage.

2. *Laboratory Methods.* — The width of the outside five rings on each disk was measured as follows: the average diameter inside bark was located by finding the long diameter by measurement, the diameter at right angles to this, and assuming that the diameter midway was the average. (See Figure 1.) The average diameter with bark was measured with a ruler, the bark removed and the diameter inside bark measured. On this average diameter, the total width of the last 5 rings, and as a check, the width of each ring was measured independently.

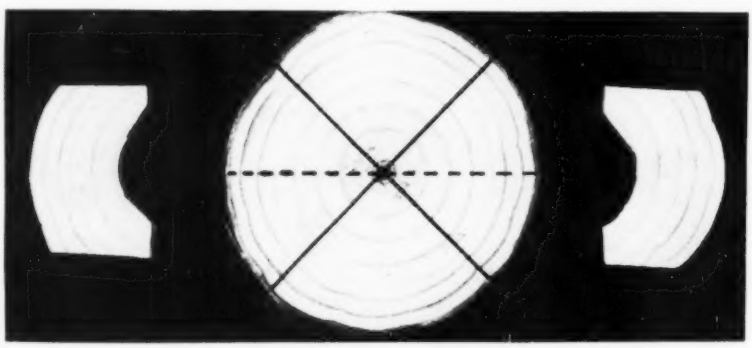

FIG. 1.—Method of locating the average diameter on the cross section and the two sections of five rings each used to determine the specific gravity. Also shown is the absence of heartwood, the uniform diameter growth and the low percentage of summerwood.

[1]Scientific Journal Series Paper No. 3095, Minnesota Agric. Expt. Sta., Institute of Agriculture, St. Paul, Minnesota.

The total age of each disk was also obtained to determine whether differences in age or relative height of the cross section and therefore possibly specific gravity, might be introduced because the disks were cut from the same absolute, but different relative heights above ground in trees of different total heights since specific gravity varies with height within a tree.

The average green-volume specific gravity based on oven-dry weight of the last 5 rings in each disk was obtained as follows: Two samples including only the last 5 rings were cut from the opposite ends of the average diameter as shown in Figure 1. When these samples were cut, areas that might contain compression wood were avoided. Treating these two blocks as a single sample, the green volume in cubic centimeters was determined by the standard water-displacement method, and the oven-dry weight by oven-drying to constant weight at 105°C. From these data the specific gravity was computed for each disk. To obtain an estimate of the precision of the specific gravity determination, several specific gravity determinations were repeated by resoaking and redrying the specimens. In spite of slight changes in volume, the average difference was not statistically significant.

The width of summerwood and springwood was measured along an average radius with a micrometer-slide comparator. The top of each sample was smoothed on a microtome and stained with phloroglucinol followed by hydrochloric acid. The dividing line between summerwood and springwood was determined by inspection of this stain and checked under the comparator. However, under the magnification of the comparator, frequently no distinct line of demarkation between springwood and summerwood within the same annual ring could be found in these young pines. (See Fig. 1.)

The average d.b.h., total height, and volume index[2] of sample trees and, for each disk the average diameter inside bark, width of last 5 rings, specific gravity, percentage of summerwood, and age are given in Table 1. The distribution of specific gravity by percentage of trees and actual number of trees is shown in Figure 2.

3. *Method of Analysis.*—All differences were tested by Fisher's Analysis of Variance. All variables that might introduce significant differences in the average specific gravity for localities also were tested to insure that these variables did not introduce systematic variation. The disk variables tested are: radial growth in the last 5 rings, diameter inside bark, age, and percentage of summerwood; and in addition, volume index and total height.

Since the minimum average specific gravity is limited by the average for springwood alone, and the density of these young trees is less than the average for the species, the distribution of specific gravity is more likely to be skewed positively and thus may vary from a normal distribution. (Fig. 2.) To insure that a non-normal distribution would not introduce errors of interpretation and also to insure that the effects of locality and specific gravity are additive, a necessary condition for analysis of variance, the logarithms of specific gravity were also tested. Furthermore, the arcsine of percentage of summerwood in addition to the original percentage was analyzed to eliminate a possible correlation between the averages and standard deviations.

[2]Volume index is the basal area at 82 inches times the total height.

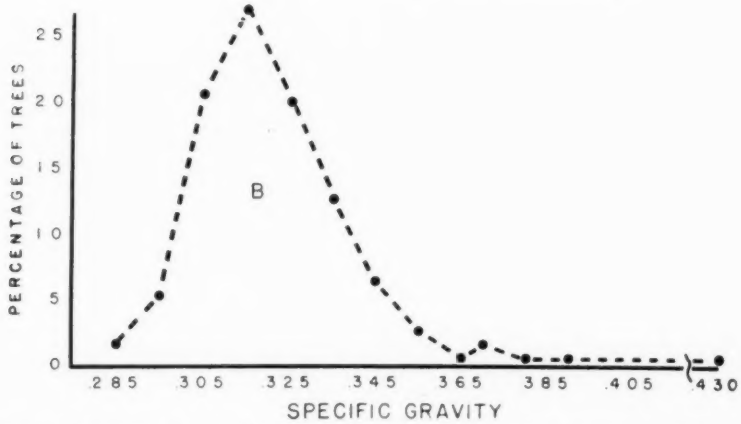

FIG. 2.—Frequency distribution of specific gravity by percentage of trees. The lower limit of this distribution is in the vicinity of the average specific gravity of springwood.

Discussion of Results

1. *Comparison of Specific Gravity by Seed Sources.*—The primary object of this investigation was to determine whether young red pine grown under identical site conditions from seed from different sources within the range of the species show genetic differences in wood density.

However, before conclusions can be drawn from these data, it is necessary to show that all variables that might introduce systematic variation in the average specific gravity by localities are either actually held constant or not statistically different. Since all trees were raised from seed planted the same year, the total age is constant, 17 years. Furthermore, the average ages of the specific gravity disks were not significantly different even though taken at different relative heights. Since only wood grown in the same calendar years was included, it was produced under identical climatic conditions. In addition, the soil—loamy fine sand—was the same, and since the area of the plot is limited no variation in water table would be expected. Therefore, site conditions should be constant. If not the random arrangement should equalize it statistically. Since the plot was thoroughly cultivated prior to planting, growth conditions were optimum.

TABLE 1.—COMPARISON OF SPECIFIC GRAVITY, PERCENTAGE OF SUMMERWOOD AND TREE VARIABLES OF 17 YEAR OLD RED PINE GROWN UNDER SIMILAR SITE CONDITIONS FROM SEED COLLECTED IN DIFFERENT LOCALITIES.[1]

Locality	Specific gravity[2]	D.b.h.	Total height	Disk diameter inside bark[3]	Age of cross section[3]	Growth-width of last five rings[4]	Summerwood[5]	Volume Index[6]
		Inches	*Feet*	*Inches*	*Years*	*Inches*	*Percent*	*Cubic feet*
			MIDWEST					
Minnesota								
Brainerd[7]	.324	2.7	21	2.3	8.0	.60	19	.62
Cass Lake	.311	2.8	20	2.3	7.7	.70	18	.65
Ely	.316	2.8	20	2.4	8.4	.71	17	.70
Menagha	.313	2.9	21	2.4	7.8	.66	18	.68
Warroad	.310	3.0	22	2.6	8.0	.66	17	.83
Average[8]	.316	2.9	20.6	2.4	8.0	.67	18	.69
Wisconsin								
Ashland	.314	2.9	20	2.4	8.1	.65	17	.62
Bayfield	.325	2.9	21	2.4	7.8	.68	18	.70
Brussels	.310	2.8	21	2.4	8.2	.63	20	.68
Cameron	.323	2.5	18	2.0	7.5	.56	19	.47
Menomonie	.322	3.1	21	2.6	7.9	.71	18	.85
Tomah	.313	3.2	22	2.6	8.0	.72	20	.87
Trout Lake	.320	3.0	21	2.5	7.9	.67	19	.73
Average[8]	.319	2.9	20.5	2.4	7.9	.66	19	.70
Michigan								
Bay City	.341	2.8	20	2.4	7.8	.63	18	.58
Bruces Crossing	.315	2.7	20	2.4	8.1	.62	17	.65
Average[8]	.327	2.8	20.0	2.4	8.0	.62	18	.62
N.W. Wisconsin and Upper Michigan	.323	3.0	20	2.5	7.8	.67	18	.79
Midwest	.319	2.9	20.5	2.4	7.9	.66	18	.70
			EAST					
Maine	.322	2.7	20	2.2	7.6	.61	19	.58
New York	.326	3.0	20	2.6	7.6	.70	16	.66
Tioga County, Penn.	.320	2.9	21	2.4	7.8	.68	19	.72
Average[8]	.324	2.8	20.4	2.4	7.7	.66	18	.65
			CANADA					
Angus, Ontario	.319	2.6	19.1	2.2	7.8	.65	18	.53
Grand average[8]	.319	2.9	20.0	2.4	7.9	.66	18	.68
Standard Deviation[9]	.016		1.96	.45		.15	3.4	.30
Coefficient of Variation %	5.0		9.8	18.8		22.7	18.9	44.1

[1]Plot located on the Chippewa National Forest.
[2]Green volume oven-dry basis.
[3]Diameter 82 in. above ground (top of a fence post).
[4]Sum of 5 outside rings on the average radius at 82 in. above ground.
[5]Based on ring width.
[6]Volume Index is the basal area in square feet at 82 in. above ground times the total height in feet i.e. the cylinder volume using the diameter inside the bark at 82 in. as the cylinder diameter. Differences in volume index for the same average diameter and total height are due to differences not shown in the second decimal place of diameter and first decimal place of height.
[7]Most of the locality averages are based on ten trees.
[8]State or regional averages are weighted averages.
[9]A pooled standard deviation based on deviations from locality means.

Furthermore, the following variables were found to be not significantly different by localities: average diameter inside bark and average width of the five outside rings on the specific gravity disks; average percentage of summerwood, and therefore probably percentage of springwood; average annual height growth from 82 inches above ground to the top of the tree, or the height growth for about the final eight years; and volume index. Total height, however, was significantly different at a level of significance midway between the 5 and 1 percent levels. Since the other variables were not significantly different, and especially since fifteen of the nineteen seed-source average heights were about equally distributed between 20 and 21 feet differing by only one foot, the assumption was made that no appreciable error would be introduced into the average specific gravity by localities by both relative and total height differences. The latter was confirmed later when the trend of specific gravity by height was determined and the average specific gravity roughly adjusted for differences in total height.

When the actual average specific gravities by seed sources were compared, the differences were highly significant. However, (see Table 1) most of this variation is due to

the high average value, .341 for Bay City, Michigan data, which is significantly different from the average .318 for the other localities. This is equivalent to a difference of 1.4 pounds per cubic foot. The range in the locality averages for the remaining seed sources is from .310 to .326. Therefore, it was suspected that the highly significant difference by localities might be due to this single seed source. This suspicion was borne out because the differences were not significant when the Bay City data were omitted.

To take advantage of larger samples as a further check, the data were grouped as follows: five from Minnesota seed sources with an average specific gravity of .316; ten Wisconsin and Michigan, including Bay City, averaging .319; and the East, consisting of three localities, with an average of .324. These data were further combined into East and Midwest. None of these regional differences were significant.

With the possible exception of the wood raised from the Bay City seed, the writers consider it safer to conclude that the wood produced in these 17-year-old trees from seed from all other sources does not differ in density. This conclusion is strengthened by the facts that differences at the 5 and 1 percent levels of significance can be due to sampling; and, furthermore, the analysis of variance, according to one authority (*2*), produces more significant results than it should.

Obviously when a search is being made for a tree-species strain with different characteristics, in this case primarily wood density, no sample that deviates considerably should be overlooked. For this reason, the Bay City, Michigan, sample was investigated further to determine whether it might be a progenitor of a denser red pine strain. All possible factors that might explain this heavier wood were investigated as follows: each specimen was very closely examined for compression wood or other causes that might introduce abnormally dense wood; several specific gravity tests were re-run; a standard ether extraction analysis for resin was made; and all variables, such as percentage of summerwood, growth, height, volume, etc. were checked for significant differences. After all checks were completed, and even after eliminating two very dense specimens, the difference between the recomputed average, .338, and the average, .318, for all other localities was still highly significant.

However, only further investigation will determine whether the heavier wood from trees from the Bay City seed source is inherited. For this reason, the specific gravity of the parent tree should be checked whenever the tree is cut. As soon as a similar plot, which is part of this genetics study, on the Superior National Forest is thinned, the specific gravity of the Bay City trees should be checked. Also the specific gravity of this second generation should be checked through to rotation age. In addition, further fundamental genetic studies will be necessary, including another generation of progeny testing to determine whether this is a new strain.

Because the Bay City seed source is a possible origin for a heavier strain of red pine, it is of special interest. The parent tree, located five miles north of Bay City in the State Park in a sandy lakeshore area, was 63 years old when the seed was collected. The average d.b.h. was 14.3 inches. Since it was 42 years old, growth at breast height has been slow—about one inch in 10 years. It is a flat-topped, broad-spreading, rugged and hardy tree from natural reproduction.

To determine whether the specific gravity of the wood of the sampled young red pines is less than the average for the species, the average, .32, was compared with the average, .44, reported by Markwardt and Wilson (*3*). This difference, representing a difference of 7.5 pounds per cubic foot, is very highly significant. The average for these 17-year trees is also significantly less than the average, .351, determined by Pillow (*4*) for Lake States plantation red pine 14 to 37 years old.

Summary

1. The variation of wood density and stand variables of trees from 19 seed sources was studied in a sample of 190 trees thinned from 17-year-old red pine stand planted on the Chippewa National Forest under identical conditions.

2. The following variables did not differ significantly by seed sources: percentage of summerwood; average diameter inside bark at 82 inches above ground; diameter growth for the past five years at 82 inches above ground; height growth for the last 8 years; volume index, or basal area at 82 inches times total height; and age of the cross-section.

3. The average density of this young red pine wood is significantly less than the average reported for the species, and also for the 14- to 37-year-old plantation red pine investigated by the Forest Products Laboratory.

4. The writers concluded from a statistical analysis of these data that significant differences did not occur in wood density in the trees from 18 seed sources, the average specific gravities of which ranged from .310 to .326.

5. The difference in average specific gravity (.341) of the Bay City, Michigan stock and the averages of the remaining 18 seed sources was highly significant; the Bay City stock, therefore, deserves further investigation as a possible origin of a heavier strain of red pine.

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Controlled Pollination of Pine Species in North America

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EACH YEAR finds an increasing number of American foresters concerned with improving forest productivity through genetic means. For reasons too obvious to discuss here, many of their efforts are devoted to controlled pollination of pines.

The standard reference on such work is Cumming and Righter's "Methods Used to Control Pollination of Pines in the Sierra Nevada of California" (*2*). This describes principles, equipment, and techniques worked out at the Institute of Forest Genetics at Placerville, California, and should be mastered by every forester attempting to control pine pollination. The present article brings together modifications developed since Cumming and Righter's circular appeared, lists equipment and supplies found useful by investigators in various parts of the country, and includes citations of a number of helpful and readily accessible references. Other articles in this issue of the JOURNAL review the genetical principles involved in tree improvement, and discuss the roles of species and individual-tree selection, hybridizing, vegetative propagation, and progeny testing.

The author wishes to acknowledge the generous contribution of specific information on methods and materials by more than a dozen of his colleagues.

Biology of Controlled Pollination of Pines

Pine trees bear separate male and female reproductive structures on the same tree. Under natural conditions, pollen from the male flowers (strobili or catkins, Fig. 1) is blown by the wind to the female flowers (strobili or conelets, Fig. 2). Making controlled pollinations between pine trees consists essentially of isolating female flowers from wind borne polen and pollinating them exclusively with pollen from known and carefully selected trees.

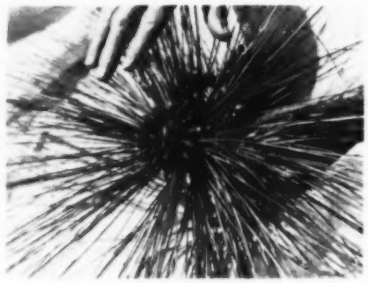

FIG. 1.—Male flowers (catkins) of longleaf pine almost ready to shed pollen. *Photo School of Forestry, University of Florida.*

Most pine species in North America flower between January and June. The northernmost species and those at highest altitudes flower latest. The flower buds are formed the summer or fall prior to flowering. Enormous quantities of pollen may be produced by each tree. During the flowering season, wind borne pollen transforms the atmosphere in areas of extensive pine forest into a yellow haze.

The pollen falls on a female flower and passes between the separated scales (Fig. 3) to the ovules. The pollen grain germinates and pushes out a pollen tube through the intervening tissues to the egg. Fertilization occurs 12 to 14 months after pollination. Growth of the cone is rapid during the period in which fertilization takes place. Eighteen to twenty months elapse between pollination and seed ripening. Büsgen and Münch's *Structure and Life of Forest Trees* (*1*) and numerous botany texts describe in more detail the reproductive cycle of pines.

FIG. 2.—Development stages of female strobili of longleaf pine, *Pinus palustris*, according to the designations of Cumming and Righter (*2*). From left to right: stage 3, bud opening; early stage 3; early stage 4; stage, 4, flower partly open; stage 5, flower maximum, or optimum stage for pollination; early stage 6, flower closing and becoming non-receptive to pollen. Figure from Wakeley and Campbell (*15*). *Photo U. S. Forest Service.*

FIG. 3.—Female strobili of longleaf pine in stage 5, optimum for pollination. Flower at left intact; note that the edges of the scales, below the spines, are thin and sharp, and that wide spaces between the scales offer easy access to pollen. Right, flower bisected longitudinally to show more clearly the wide spaces between scales. Figure from Wakeley and Campbell (*15*). *Photo U. S. Forest Service.*

Tree Climbing

Pending the concentration of great numbers of grafted or rooted clones in breeding orchards of low-crowned trees, the costliest part of controlled pollination of pines is the climbing necessary to reach the flowers. Six trips up and down a tree are a usual minimum. This many trips with ordinary climbing irons injure the tree excessively. A non-injurious type, the Baumvello (*7*), appears not to have been tried in this country. Since, in addition, the last feather-lined skyhook was buried with Paul Bunyan and the modern helicopter has not

yet been adapted to tree breeding, present-day breeders use other devices, ranging from simple ropes to elaborate truck-mounted ladders.

A ½-inch rope 100 or more feet long is undoubtedly the most portable climbing device. It is doubled over a live limb in the lower part of the crown, either by direct cast or by means of a lighter line carried by a weight or an arrow. The doubled rope is climbed by the foot-lock method (*2, 12, 13*). Trees 30 to 50 feet to the first live limb are regularly climbed in this way, but only by breeders in constant practice and the extreme of hard physical condition. A number of companies supply special ½-inch tree climbing rope in 3 or 4 strands and well over 2,000 pounds tensile strength. Somewhat smaller ropes would be strong enough but, even when doubled, are too slender to grasp securely.

Much of the fatigue of climbing with the doubled rope can be eliminated by using the taut line hitch with a tree saddle or a Spanish bowline on a bight (*6, 12, 13*). The taut line hitch holds the climber at whatever point he chooses and permits complete relaxation between heaves on the rope. With this hitch, an assistant on the ground can help haul the climber into the tree. To avoid energy-consuming and mutually destructive friction of rope over limb, the rope may be run through a pulley hoisted up to and held at the first (or preferably the second) live limb in the crown by means of a second rope.

British forest geneticists have developed a pair of modified bosun's chairs which serve as platforms that can be moved alternately up the tree as the climber progresses (*11*). Frank Woods, of the Southern Forest Experiment Station, Marianna, Florida, has reported that they work satisfactorily except that they are slow to manipulate. The British claim that trees up to 22 inches d.b.h. can be climbed with these modified bosun's chairs.

The rising generation of tree breeders seem as a group to find ladders more effective than ropes for getting into the crowns.

FIG. 4.—Swedish tree climbing ladder. The climber assembles the ladder as he progresses up the tree. The bottom of each section interlocks with the top of the section below it, and the top of each section is chained to the tree.
Photo School of Forestry, University of Florida.

Of the ladders reported, the special Swedish tree climbing ladder manufactured by Wikstrand and Berg seems by far the most generally effective under the widely varying conditions encountered in practice. This ladder comes in 3-meter sections which are fitted together and chained to the tree as the climber, supported by a safety belt, progresses, upward (Fig. 4). Its high initial cost is compensated for by savings in time and labor. Once the equipment is piled at the base of the tree, a climber with an assistant to pass sections up to him can attain a height of 80 or more feet in less than ten minutes. Because of its light weight (less than 10 pounds per section) one man can easily carry four sections of this ladder for a mile along a forest trail. The ladder unfortunately comes equipped with chains lacking secure fasteners, and too short for the lower trunks of large trees, but longer chains and adequate dog-chain or tire-chain fasteners are easily added at little cost. Large-footed climbers who find the erected ladder not only rather narrow but also uncomfortably close to the tree endure these inconveniences for the sake of the equipment's other merits.

For low-limbed trees in open stands, numerous workers are using aluminum or magnesium alloy extension ladders or three-legged orchard ladders, which may be obtained through mail order houses or local hardware stores.

Truck mounted ladders, which reduce injury to the trees and greatly improve access to the flowers on trees of moderate height, are being used in situations where there is room to maneuver these cumbersome devices. François Mergen, Southeastern Forest Experiment Station, at Lake City, Florida, uses a 20-foot extension ladder mounted on the back of a pick-up truck for working in plantations of young trees. Robert M. Allen and N. M. Scarbrough of the Southern Forest Experiment Station at Gulfport, Mississippi, have designed a special bracket for holding a 40-foot extension ladder on the side of a 1½-ton truck; the top of the lower section is guyed by two wire cables running to a heavy pipe secured to the far side of the truck, and by a rope to the tree being worked (Fig. 5). L. T. Easley, Westvaco Experimental Forest, Georgetown, South Carolina, has a 50-foot ladder made of 1½-inch pipe mounted on a war surplus half track; he reports that this ladder can be moved through the woods in a vertical position. In some localities, power companies or municipal authorities may be willing to rent or lend their truck mounted ladders to tree improvement workers.

The most careful workers unavoidably break off twigs and branches and bruise the tree with every climb. After three or four years of climbing a tree will be much battered. To avoid these injuries, Scandanavian workers have built scaffolds and permanent lad-

ders around their most valuable trees (*2*).

Safe Access to Flowers or Cones in Crown

Regardless of how the tree crown is reached, a body belt and safety belt are essential for safe work within it. Tree improvement workers use either linemen's belts or special tree climbing belts. A well designed and padded belt pays for itself during the first day of use.

With his safety belt around the trunk of the tree, the breeder can, with the help of a branch hook, reach most flowers on the same level and within 8 or 10 feet of the trunk. This hook is made by brazing a suitable bent piece of stiff welding rod to a piece of 6-gauge electrical wire 6 feet long. Such wire is stiff enough to be held horizontally without bending and yet flexible enough to wrap around the main stem or a branch base and hold the branches once they have been pulled in. This leaves the tree breeder with both hands free to work.

Branch ends that cannot be reached with a 6-foot wire will usually be too stiff to pull in. Many flowers and cones on such branches can be reached by passing a rope around the trunk and over a branch or a pair of branches higher up in the tree and rigging a taut line hitch (*6, 12, 13*) to support the greater part of the breeder's weight with complete safety as he works out from the trunk along the horizontal branches.

The upper part of the main stem of many young pines is slender, brittle, and excessively dangerous to climb. Keith Dorman (*3*) braces the tops of such young trees with three 2 by 2's, 10 to 16 feet long, wired to the main stem at 120-degree intervals around its circumference. Guy wires are run from the upper part of these reinforcing strips to the butts of nearby trees. With this technique the uppermost branches of very young trees can be reached without danger of the crown breaking out.

A light weight aluminum or aluminum alloy pole, obtainable in sections of any desired length, can

FIG. 5.—R. M. Allen and N. M. Scarbrough have designed a special bracket for holding a 40-foot extension ladder on the side of a 1½ ton truck.
Photo by U. S. Forest Service.

be used for collecting catkins and some kinds of cones from the ground. The manufacturer claims that it can be used in lengths as great as 90 feet but in practice the author finds that it takes two men to manage 50 feet.

Isolating the Female Flowers

Female flowers are isolated by covering them with bags which are impervious to pollen. For best results bags must be light and durable, and must permit the free transmission of air, heat, and water vapor so that the covered branch and conelet will not be suffocated or injured through sunscald or overheating. The bag should also be transparent so that flowers may be examined and pollinated without removing the bag. The paper and parchment bags used in agricultural crop breeding become waterlogged and are easily torn by stiff needles and sharp conelet spines. Unless cellophane bags are covered with larger paper bags, water droplets condense on the inner surface of the cellophane, act as lenses in the sun, and cause sun-scalding of the enclosed twig.

FIG. 6.—Westvaco ladder, a collapsible 50-foot ladder built by the West Virginia Pulp and Paper Company from 1½-inch pipe and mounted on a war surplus half track.
West Virginia Pulp and Paper Company photo.

Workers at the Institute of Forest Genetics, Placerville, California, have had excellent success with an 8 by 14-inch canvas bag with a plastic window in one side (*2, 10*). The Placerville bag is expensive to construct but can be reused for 3 to 5 years by cleaning and sterilizing it after each pollination. It is rather large and heavy for small-twigged pines.

Many pine breeders prefer synthetic sausage-casing bags to canvas bags of the Placerville type. Casings may be purchased in various sizes to fit the species to be bagged: 24 to 30-inch lengths of 3¼ to 3½-inch diameter casing, cut in half and stapled as illustrated in Figure 7, are about right for many kinds of pines. These bags transmit water vapor freely, are light, tough, and transparent, and are cheap enough to be discarded without reusing.

The closest rival to synthetic sausage-casing, in cheapness, convenience, and effectiveness, may be a light plastic tube, ventilated through and attached to the twig by a pollen-proof cloth collar—a device developed by Roland E. Schoenike, Southern Forest Experiment Station, Crossett, Arkansas.

The female flowers should be bagged before they emerge far enough for pollen to fall on them, that is, at stage 2 or earlier (Fig. 2).

Regardless of the type of bag used, it is customary to pad the

twig with cotton at the point where the mouth of the bag is fastened around it. Before the cotton is wrapped around the twig, enough needles should be pulled or trimmed off so that conelet examination and pollination are not interfered with. The author trims all needles back flush with the end of the conelets. The resulting "paintbrush" of needles holds the pollination bag away from the conelets and prevents their injury.

Bags may be tied on with coarse, soft cotton string cut to suitable lengths in advance of climbing, or fastened with 8-inch commercial plant ties ("Twist-ems") or with pipe cleaners. Every motion is precious when swaying in a tree top and many workers prefer the latter two fasteners because they can be tightened effectively with one hand.

To save other motions in the tree, the cotton and fastener can be placed in each bag in advance of climbing; for the most exacting work, bags known to be pollen-sterile may be sealed shut with gummed paper or masking tape till the moment of attachment.

Pollen Handling

Pollen can be obtained, as soon as the first catkins on the tree begin to shed, by picking slightly less advanced catkins from the same tree; if the pollen grains have developed far enough (*2*), catkins may be picked even a few days before first shedding.

If 1/10,000 contamination does not worry the tree breeder, the catkins may simply be spread on newspapers in a dry, draft-free room and allowed to shed their pollen. Experiments by Jonathan Wright, Northeastern Forest Experiment Station, Chestnut Hill, Pennsylvania, indicate that contamination from this procedure is negligible. If, however, absolute certainty of pollen purity is necessary, then freshly collected catkins can be washed free of foreign pollen (*2*) and extracted in any one of several types of pollen-tight extractors (*2*, *15*). A number of workers have recently used synthetic sausage-casings for extracting small lots of pollen, with great success (*15*).

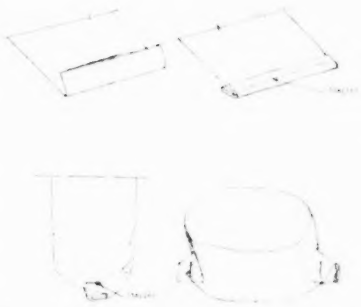

FIG. 7.—*Upper:* Pollen proof quadruple fold to close end of synthetic sausage casing bag. Developed by Bruce Zobel, Texas Forest Service. *Lower:* Transverse staple, applied with plier stapler just before bag is attached to twig, to keep bag distended so that it will not collapse and injure conelets.
Contributed by R. G. Hitt, University of Wisconsin.

The air surrounding the catkins during extraction must be warm, or the pollen will not be discharged, and dry, or the catkins and pollen will mold. Extracted pollen must be bolted through voile or 60-mesh screening to remove pollen maggots, particles of catkins, and other impurities. Pollen extracted from catkins in a voile or fine cheesecloth bag enclosed in a length of sausage-casing may be withdrawn without contamination by thrusting the needle of a pollinating syringe into the casing.

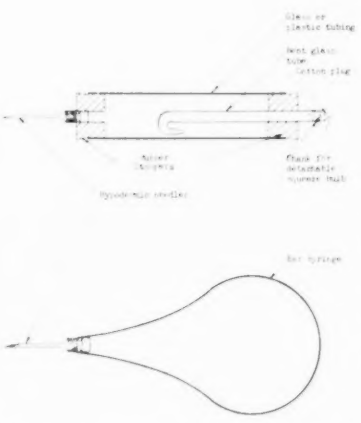

FIG. 8.—Apparatus used to inject pollen onto bagged flowers. *Upper:* Carburetor type mixes pollen and air and injects the mixture into the pollination bag. Detachable one-way squeeze bulb (not shown) can be used on several pollinators in succession, without contamination. *Lower:* Hypodermic needle in decapitated cat syringe. Needle is reversed when not in use and held in syringe and rendered leak proof by strip of adhesive tape.
After Wakeley and Campbell (15).

Pollen extracted at room temperature and low relative humidity will remain functional for several weeks. It is best stored, however, in a refrigerator where the low temperature and low relative humidity will prolong its viability. Some workers report excellent results from storing pollen in a deep freeze locker. Duffield's latest experiments on pollen storage and testing indicate that pollen stored for about a year at 0° C. and 25 percent relative humidity will still produce pollen tubes in test culture (*5*). Although Jonathan Wright warns that ability to germinate and form pollen tubes does not necessarily indicate that pollen is functional, numbers of workers have gotten good seed sets with year-old pollen.

Pollination, Records, and Protection of Cones

The devices used for pollinating the flowers have been many and varied. Wright and Schreiner use a sharp pointed medicine dropper to inject pollen through the isolation bag onto the female flowers. A piece of cotton in the bulb end of the dropper prevents pollen from entering the rubber bulb. The dropper and extra pollen are carried in a 10 cc vial. Twenty to forty bags can be pollinated with a single cc of pollen. Several other workers use hypodermic syringes with rubber bulbs substituted for the plungers. The 15 to 16-gauge hypodermic needles on such syringes should be as short as possible, and protected with corks when not in use.

Figure 8 illustrates two types of pollinators that have proved highly serviceable. The pollinator in Figure 8 (upper) has the advantage of a carburetor-like action that makes it possible to make a larger number of pollinations with a single cc of pollen; that in Figure 8 (lower) has the advantage of cheapness and extreme simplicity. The one-way squeeze bulb used

with the type in 8 (upper) can be transferred in turn to a succession of different pollinator cartridges. John W. Duffield, University of Washington, suggests that the pollinator tube or cartridge in 8 (upper) be made of plastic rather than glass. With 30 cc pollinators (either 8 upper or 8 lower) half full of pollen, few or no field sterilizations of equipment or transfers of pollen should be necessary in an ordinary hybridizing program.

Extractors and pollinators must be sterilized before reuse. Bruce Zobel, Texas Forest Service, and Philip C. Wakeley, Southern Forest Experiment Station, report that isopropyl alcohol (rubbing alcohol) is effective for sterilizing glass, wire, and plastic but has an adverse effect on rubber. High temperature sterilization, 80° C. for 24 hours, will kill pollen satisfactorily without injuring equipment (2). Hodgkins (8) reports that temperatures of 80° to 82° C. for 15 hours will kill pine pollen.

Old pollen, or pollen extracted under adverse conditions, should always be tested for germination before using, and it usually pays to test fresh lots also, lest climbing and flowers be wasted through application of nonfunctional pollen. Methods of pollen testing have been described by a number of authors (2, 4, 5, 9); the vapor culture method described by Duffield (5) is excellent.

Pollen should be applied to the female flowers when there is enough space between the scales to allow pollen to pass in to the ovules—that is, in stages 4 and 5 of development (Fig. 2, 3). The receptive conelet scales are usually horizontal and have a striking color and succulence which is characteristic for each species. After pollination the puncture in each bag is covered with a piece of Scotch, friction, adhesive, or grafting tape.

Each pollinator must be unambiguously labeled with the lot number of the pollen it contains. Each twig must be labeled to indicate the pollen parent for each bag and then further marked with a streamer to facilitate cone collection. Without accurate and complete labeling and record keeping, the process of pollination is not under control. A diary listing dates and pollinations is invaluable to the tree improvement worker. The author prefers to plan his pollinations in advance, make embossed, copper-wired monel labels in the comfort of his office, and carry the labels up the tree in the buttonholes of the lamentable shirt he wears for such work. Some workers prefer foil labels (with reinforced eyelets) on which the essential information can be indented with a pencil while in the tree. Aluminum or zinc foil labels are superior to copper, which tarnish and are hard to read after twenty months of exposure.

Pollination bags may be removed as soon as the conelet scales have thickened enough to prevent further pollination. Pollen bag removal can be delayed from two to three weeks or, if the twigs grow slowly enough, the bags can be left on the tree until cone maturity. Bag removal should be delayed as long as possible, as the bags shield the strobili against insects and diseases.

During the 20-month period between pollination and seed maturity, squirrels, insects, storms, and disease often make heavy inroads on the potential harvest. Cloth bags can be placed over the enlarging cones to prevent insect damage. A. E. Squillace of the Intermountain Forest and Range Experiment Station recommends placing a metal flange around the tree trunk to prevent squirrels from reaching the cones. If a tree is to be pollinated two years in succession, the one-year-old cones may be covered, at the time of the second pollination, with bags just large enough to hold the mature cones. In any event, cones from controlled pollinations (which may have cost five dollars or more apiece to produce) should be covered with bags about a month before ripening, to prevent loss of seed through natural cone opening.

Pollination Equipment and Supplies

With one or two exceptions, the following equipment and materials have been used in controlled pollination of pines by American workers during the past one to three seasons. Although no pretense to completeness is made, and prices are approximate only and subject to change, the list should enable a breeder to assemble a satisfactory kit for his own use. In cases in which a specific supplier is named, no final endorsement or exclusive recommendation is intended or implied; equivalent materials can no doubt often be obtained from alternate and in some instances more convenient sources.

Rope. Manila, special friction resistant tree-climber lay, 3 or 4-strand, or Maritime Manila, water-repellent and mildew-resistant; ½-inch. One quotation, ½-inch by 120 feet, ends wrapped, $6.60 to $6.90. Plymouth Cordage Co., Plymouth, Mass. A. M. Leonard and Son, Piqua, Ohio. Bartlett Tree Trimming Equipment Co., 3003 E. Grand Blvd., Detroit 2, Mich.

Climbing "irons," noninjurious to tree. Baumvello—Das Baumsteigerrat. H. Schneebeli and Co., 307 Schaffhauser Strasse, Zürich 50, Switzerland. (Not known to have been tried in United States.)

Swedish sectional tree climbing ladder, aluminum alloy. Model WI-BE, manufactured by A. B. Wikstrand and Berg, Ltd., Mora, Sweden. American agents, Sandvik Saw and Tool Co., 47 Warren St., New York 7, N. Y. 10 pounds per 3-meter section; all sections except basal section identical. About $33 per section.

Magnesium alloy extension ladder. Two 20-foot sections plus overlap to give 40-foot usable length; weight 57 pounds. Montgomery Ward Co. No. 75 B 6835 R. About $100.

Magnesium ladders. Fruit-picking and other styles made in lengths to order at about $5 per foot. Modern Magnesium Products Inc., Pearl St., Palmer, Mass. (Dr. Scott Pauley writes that this company plans to make special ladders for forest geneticists.)

Truck mounted ladder. Murray Manufacturing Co., 1250 Atlantic Ave., Brooklyn 16, N. Y.

Hydraulic or pneumatic extension towers. Mobile Aerial Towers Inc., 1405 N. Clinton St., Fort Wayne, Ind. Schramm Inc., West Chester, Pa.

Aluminum or aluminum alloy sectional pole, for collecting catkins and cones without climbing. Sections of varying lengths. 70c per foot plus $1 per section; a 6-foot section $5.20, etc. J. B. Sebrell Corp., 300 Los Angeles St., Los Angeles 13, Calif.

Branch hooks, as described in text. Welding rod and #6 copper wire from local hardware and electrical supply houses.

Tree harness or safety saddles. Bartlett; Leonard and Son. (Addresses under *rope*). About $13 to $15.

Safety belts. Through wholesale electrical supply houses. About $20.

Eye protector, to safeguard against sharp needles and twigs as well as bits of bark, etc. Numerous makes and models. Essentials: close fit to forehead, temples,

and cheeks; wide-angle vision; freedom from fogging. Clearview Visor Goggle, Model No. 1, $2.25, Jones and Co., 125 Catlin Ave., Rumford, R. I. meets these requirements and can be worn over ordinary spectacles.

Placerville pollination bag. Homemade; for directions see (*10*).

Synthetic sausage casing, for pollination bags and pollen extractors. Various makes, lengths, strengths, and sizes. Transparent Packing Co., 3520 South Morgan St., Chicago, Ill.—Tee-Pak clear, high-stretch, either regular-weight or heavy-weight, as preferred; "3¼" or "3½-inch diameter" (refer to diameters of sausages made from these casings; the widths of the flattened casings as received are 4½ and 4⅞ inches, respectively), ordered in 24 or 30-inch lengths and cut in half, make bags suitable for many species of pines; in regular weight, 3¼ inch by 24-inch casings cost about $83 a thousand. Visking Corporation, Chicago, Ill.; about $35 for 500-foot length of casing, exact price depending on width and strength.

Staplers, regular type for making quadruple folds in bags in office; plier type for fastening bags in expanded position immediately before attachment. Any reliable make that inserts staple ½ inch long.

Twig-wrapping cotton. Nonabsorbent, nonsterile cotton at 50c to 60c per 1-pound roll at local dry goods or department stores is not only cheaper than but superior to surgical absorbent cotton, because it takes up less water while in use.

"Twist-ems," paper-covered wires for fastening plants to stakes. For attaching bags to twigs. Nursery or garden supply stores; 8-inch length, 25c per 100, retail.

Pollen extractors. See (*2, 15*) write Institute of Forest Genetics, Placerville, Calif., for details of aerating apparatus for large-scale extracting laboratory described (*2*).

Pollen sieves. Construct of 60-mesh monel screen from local hardware stores, or of cotton voile stretched tightly over and cemented to large ends of 5c plastic funnels 2⅞ inches in diameter, from Dime Store.

Pollen containers. 2-ounce screw cap Rx bottles and 10-cc vials; from local druggist or scientific supply house.

Pollen testing equipment. See (*2, 5*).

Parts for pollinator in Figure 8 (upper). Hypodermic syringe bulb as above; glass or Tygon plastic cartridges (30 cc. capacity suggested), small glass and rubber tubing, one hole rubber stoppers, etc., from local druggists or scientific supply houses.

Parts for pollinator in Figure 8 (lower). One-ounce rubber ear syringe, Faultless Rubber Co., Ashland, Ohio, No. 211, or equivalent; 39c to 49c from local druggist; 16-gauge ¾-inch veterinary needle No. 507 NR by Becton, Dickenson and Co., or equivalent, 25c retail.

Tape, for assembling pollen extractor described in (*15*), fastening reversed needle in pollinator shown in Figure 8, and especially for sealing needle punctures in synthetic sausage-casing bags. Any good waterproof gummed tape—Scotch, friction, surgical adhesive, or grafting. A supply of 1-inch Scotch and ½-inch waterproof surgical adhesive makes a good combination for all ordinary needs.

Gummed labels, for pollinators, etc. Any stationer's. Surgical adhesive tape is also good for pollinator labels.

Twig marking tags. Aluminum Weatherproof tags, #51, 3½ by ¾ inches, cardboard backed, with reinforced eyelets, strung on copper wires; indented with ordinary pencil. Chase Nursery Co., Chase, Ala.; $10 per 1,000, f.o.b. Chase. Also Indestructo metal tree labels #2, large size, zinc preferred to copper; same source.

Embossed labels. Durable, easily legible labels can be made with Roover's portable (approximately $35) and nonportable (approximately $150) label embossers. Monel or aluminum labels made with these machines cost about 2c each. Roover Brothers, Inc., 3611 14th Avenue, Brooklyn 18, N. Y.

Copper wire for labels. Burned armature wire can often be obtained free from local motor and armature repair shops.

Unbleached muslin, for 1 by 24 to 36 inch strips to flag branches bearing cones from controlled pollination; at dry goods stores, 40c per yard or less.

Envelopes for hybrid seed. "Spear" safety envelopes, sturdy and leakproof, in 1 ounce to 16 ounce sizes. Price about $14 per 1000, but variable with size. Heinrich Envelope Co., Minneapolis, Minn.

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Loblolly Pine Seed Production Areas

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FORESTERS and geneticists have long recognized the need for reliable volumes of tree seed from sources of known quality. Brink (*1*) suggested improving the genetic quality of red and jack pine planting stock by selecting the better natural stands and converting them into seed orchards.[2] Schreiner (*2*) called attention to the early plantings of Scotch pine in Europe that were made without regard to seed source and the resultant stands of crooked trees unsuitable for saw timber. This same disregard for seed source is still the rule among seed collectors in this country.

In 1950 after observing local seed collection practices West Virginia Pulp and Paper Company embarked on a seed collection program to obtain seedlings for future plantings from the highest quality parent trees available. This led to the establishment of loblolly pine seed production areas. The first seed production area was established at Westvaco in January 1951 (Fig. 1). One hundred and seven trees were released in a 5-acre area. Seed was harvested from this area in October 1953, three growing seasons after release. Seventy-four of the selected trees were cut and yielded 105 bushels of cones. These yielded 126 pounds of seed—19 ounces per bushel of cones—on the first run through the winnowing machine. A second run through the winnowing machine at a higher speed yielded 115 pounds of seed or 17.5 ounces of double cleaned seed per bushel of cones. Cutting tests of the seed showed an average soundness of 85 percent. A sample seed count showed 18,100 seeds per pound. Cone count ranged from 225 to 350 per bushel and green cones weighed 28 to 31 pounds per bushel. Cone collection cost was below average because of the concentration of high yield trees.

FIG. 1.—Selected loblolly pine trees on Westvaco's first seed production area.

Seed fall studies carried on for the past eight years indicate there is a tremendous increase in seed production by loblolly pine trees the third, fourth, and fifth years after release. These results parallel those reported by Wenger (*3*). After the fifth year seed production falls off and may then follow the trend of normal seed production (Table 1).

The stimulation of cone production by release from close competition is the basis for volume seed production by selected trees. And an area selected for release must have a well stocked stand if satisfactory results are to be achieved.

Individual seed trees are selected on the basis of stem and crown form, branching habits, freedom from disease and insect attack, wood density, and growth. Depending on size, selected trees are spaced 35 to 50 feet apart resulting in about 30 trees per acre. Wenger (*3*) in studying the effects of release spaced trees 2½ to 3 times the crown diameter apart. However the selection of only the very best trees for seed production may re-

[1]Research Forest operated by West Virginia Pulp and Paper Company.

[2]The Southern Forest Tree Improvement Committee in January 1953 defined:

1. A seed orchard as an area planted to trees especially for the production of seed.

2. A seed production area as a selected natural stand treated to produce seed at a given time.

TABLE 1.—SEED PRODUCTION PER MIL ACRE FROM 40 YEAR OLD LOBLOLLY PINE STAND CUT TO EIGHT TREES PER ACRE IN 1946 AND COMPARISON OF SEED PRODUCTION WITH UNCUT 60 YEAR OLD STAND

	Seed year						
	1947	1948	1949	1950	1951	1952	1953
40-year-old released stand sound seed per mil acre	18	27	179	241	202	154	67
Percentage of 1947 production	100	150	995	1,338	1,122	856	372
60-year-old unreleased stand sound seed as percentage of 1947 production	100	95	64	44	107	110	48

sult in much wider spacing. Five Westvaco loblolly pine seed production areas established to date have 21, 16, 9, 11, and 14 trees per are respectively. Three slash pine plantations converted to seed production areas have 25, 29, and 58 trees per acre. These plantations are 22 and 20 years old.

Although slash pine cones are picked from the standing tree with little difficulty, loblolly pine cones are firmly attached to the twig and harvesting cones from the standing tree is costly and results in damage to future cone crops. Because of this, loblolly trees are cut at the time of seed collection. The felling of the seed trees necessitates the selection and release of a new area each year for harvesting three years or more later if seed is to be collected each year.

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Preliminary Report on a Study of Races in Black Walnut

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Are there geographic races of black walnut that must be taken into account in procuring seed for forest planting, or local races or individual variations that can be utilized to improve timber or nut production? A test of seed from several points within each of three broad climate zones indicates that all three types of variation may occur.

A TEST of black walnut (*Juglans nigra* L.) seed from different geographic origins was started in 1944 at the Department of Forestry and Conservation of Purdue University, West Lafayette, Indiana.

The study was undertaken to develop information on geographic and local races and on individual genetic variation in this important timber and nut species. Primary emphasis was placed on genetic variation as it affects timber yield rather than nut yield.

Foresters and botanists located at various points within the range of black walnut were asked to cooperate by sending seed—up to 300 nuts from as many as 5 trees. The trees were to be average native specimens of any age or spacing; actually most were open-grown very fruitful specimens. Adequate data on locality and altitude of origin, habitat, phenotype, and spacing of parent trees were submitted in nearly all cases.

The seeds were husked, floated in water (some lots were 100 percent empty), and stratified in moist sand in an unheated barn until planting time.

Samples of 10 air-dry seeds per tree were weighed and cracked to determine nut quality. The nuts were scored on four counts: shell thickness, ability of the halves to come out entire, percentage of meat, and taste. They were given a score of 0, 1, or 2 on each count. A total score of 8 indicated a superior nut; a score of 0 a worthless nut.

The planting site was a level abandoned field that previously supported a heavy weed cover of timothy and whitetop. The soil was a Miami clay of pH 5.1, medium in available phosphate and very low in available potash. The land was plowed and double-disked before planting.

The seeds were planted on May 13-20, 1945. At the time, the ground was soupy from heavy rains. Germinated seeds were planted in dibble holes; ungerminated seeds were merely pressed in with the heel.

Clean cultivation after planting was planned. However, this was not done because of unforeseen labor difficulties. Consequently the weed cover soon became as dense as before plowing.

The planting was organized into three separate experiments:

1. A regional experiment of 4 blocks of 36 rows each.
2. A local Indiana experiment of 5 blocks of 16 rows each.
3. A local Alabama experiment of 5 blocks of 4 rows each.

The rows were 3 feet apart, 90 feet long, and randomized within blocks. Each row was the progeny of a single tree. In the local Indiana experiment 45 filled seeds were planted per row. In the other two experiments 60 filled seeds were planted per row.

Height measurements of all trees were made in October 1947, and general observations of the planting were made. Row means were used in all statistical calculations.

Results

Variation in nut characters.—The average dry weight of nuts from individual trees ranged from

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[2]Maintained by the Forest Service, U. S. Dept. Agric.

TABLE 1.—AVERAGE 3-YEAR HEIGHT OF BLACK WALNUT TREES, AND LEAF PERSISTENCE IN LATE OCTOBER 1947

Region of origin (based on length of frost-free season)	Basis: rows	Height		Rows containing trees with—		
		Range[1]	Mean	Many green leaves	Few green leaves	No leaves
	Number	*Inches*	*Inches*	*Percent*	*Percent*	*Percent*
			Regional Test			
Northwest (150-155 days)	17	12.8-14.6	14.0	0	6	94
Central (160-180 days)	60	11.3-15.4	13.5	14	20	66
South (190-260 days)	50	12.4-20.2	16.0	38	31	31
			Local Indiana Test			
Indiana (170-180 days)	53	11.7-17.3	15.1	20	22	58
			Local Alabama Test			
Alabama (210 days)	18	11.6-13.5	12.4	67	16	16

[1]Ranges in means of individual tree progenies.

8.2 grams to 37.0 grams. Variation among nuts from the same tree was slight. There was no correlation between origin and nut size—with one exception.

This exception was in nuts from two trees (about 10 miles apart) in central Virginia. The nuts from these trees were similar in their large size (32.4 and 37.0 grams per nut), and in shape, sculptoring, and extreme thickness of shell. This indicates the possibility of a local race in that area.

Of the parent trees sampled, four from Iowa, Minnesota, and Ohio were considered very superior and worth propagating. Nuts from these trees had total scores of 6, 7, or 8 (as against a total score of 7 given the well-known Stambaugh and Thomas varieties). Each of these superior parents bore fruit heavily in 1944, but had relatively small nuts.

Survival.—Average survivals three seasons after planting (October 1947) were 23, 28, 33 percent respectively for the regional, Indiana, and Alabama experiments. Survival ranged from 0 to 80 percent in individual rows, and from 5 to 44 percent for the offspring of individual trees.

There was no apparent correlation between survival and any of the following factors: degree of germination before planting, geographic origin, seed weight (including seed coat), and growth rate of survivors.

Height.—Height growth (Table 1) was below optimum, because of lack of cultivation. There was no correlation between height and seed weight or degree of germination before planting.

In summarizing the data, three regions of origin were recognized, based on length of the frost-free season:

(1) *Northwest*, including Iowa, Minnesota, Wisconsin, and Michigan. (2) *Central*, including Illinois, Indiana, Maryland, Missouri, Ohio, Pennsylvania, West Virginia, and the mountainous part of Virginia. (3) *South*, including Alabama, Georgia, North Carolina, Oklahoma, South Carolina, Tennessee, and the coastal plain section of Virginia.

For the regional experiment, data from 28 families (progenies of individual trees) were subjected to analysis of variance. Significant differences (at the 1-percent level) were found between regions and within regions. These suggest racial differences.

Data from the two local experiments were also analyzed statistically. Significant differences were found between progenies from different regions and—except in the Alabama experiment — between progenies from the same region. Lack of significance in the Alabama experiment may be due partly to the small number of parents used.

The individual tree progeny that had the next-to-highest growth rate came from a forest-grown Georgia tree designated by the collector as exceptionally fast growing for its cove site. This was the only tree singled out this way by a collector; it indicates the possibility that trained observers can pick out exceptional parents.

Leaf persistence.—In leaf persistence in late October 1947 there were pronounced row-to-row differences due to the influence of the parent trees. There were also differences due to environment: no leaves remained on trees surrounded by whitetop, although as many as half the leaves remained on trees surrounded by timothy.

Individual trees were scored for leaf persistence on the basis of the performance of trees in timothy cover (Table 1). Trees from the South held their leaves longer than those from the North. Perhaps there were differences between progenies from the same region; but the method of scoring precluded detection of such differences.

Other characters. — Noticeable row-to-row differences in leaf size were observed, suggesting genetic differences in this character. No measurements were made. Nor were measurements made of the scattered rabbit damage and winter dieback, in neither of which was there row-to-row variation.

Discussion

The study shows the presence of three "races" in black walnut, and hints strongly at the presence of local variation in growth rate. Further work will be needed to show whether the races are moderately distinct or merely portions of clines[3]; and whether there are local races within the broad geographic races or the local variation is merely random.

A few words about the study itself: The request for 300 seeds per parent necessitated drastic selection for fruitfulness—perhaps at the expense of vigor. Also, the labor of collecting, cleaning, and shipping the seeds was considerable.

[3]A "cline" is a population in which the variation is continuous.

Subsequent experience with other species has convinced the author that such trials could be conducted with much smaller numbers of seeds—perhaps only 10 to 25 per parent. With clean cultivation and 1-, 2-, or 3-tree plots on a small homogeneous area, the statistical efficiency could be made much better than with the large plots used in this study.

In addition, such small samples would allow the testing of larger numbers of parents, the testing of relatively unfruitful but vigorous parents, and the combining of seeds from several parents as a "locality" sample. (In the study it was necessary to represent some localities by only a single parent, since only one tree could be found producing the required number of seeds.)

Acknowledgments

Grateful acknowledgment is made to the more than 60 workers who collected and sent in nuts, and to members of the staff of Purdue University—especially the staff of the Department of Forestry and Conservation—who helped in the study.

Top Growth and Root Development of Rooted White Pine Cuttings[1]

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PREVIOUS WORK (*1, 5*) on rooting of cuttings makes the characteristics of the trees that develop from them of special interest to forest geneticists. Good results may help solve some of their most difficult problems. This paper describes the subsequent growth in several trial plantations of rooted white pine cuttings.

Plantations of rooted cuttings and seedlings have been established in several areas in Wisconsin to study the development of rooted cuttings after planting. After cuttings had rooted, they were transplanted from the cutting beds to the nursery and grown for 2 or 3 years. They were then planted in the field in rows in groups of 5, alternating in a checkerboard pattern with groups of regular 2-2 nursery transplant stock for comparison. Records were taken annually on survival and growth.

After 7 to 9 years the survival rate of 640 rooted cuttings planted in 4 plantations was 83 percent; that of 584 seedlings was 89 percent. Most of the losses in both groups occurred the first year or two after planting. The poorer survival of the cuttings probably was because in the nursery many of them developed only one or two long heavy roots which had to be pruned severely before planting in the field.

TABLE 1.—AVERAGE ANNUAL HEIGHT GROWTH OF ROOTED CUTTINGS AND SEEDLINGS OF WHITE PINE IN THREE DIFFERENT PLANTATIONS IN WISCONSIN.

Location[1]	Type of tree	Tree	Average annual height growth[2] 1947	1948	1949	1950	1951	1952	1953
		No.	Inches						
Wood Co.	Cuttings	100	9.0	9.3	8.1	17.8	25.5	[3]	[3]
	Seedlings	100	8.0	9.0	8.0	17.8	25.9		
Dane Co.	Cuttings	67				13.5	17.8	21.1	
	Seedlings	62				14.3	17.2	22.5	
Marinette Co.	Cuttings	117					3.8	6.1	4.8
	Seedlings	86					3.3	6.2	4.3

[1]Trees in the Wood and Dane Co. plantations were planted in 1945 in the open; trees in the Marinette Co. plot were planted in 1947 under an aspen overstory.
[2]Length of current season's leader to nearest one tenth inch.
[3]No height measurements were taken in Wood Co. in 1952, or in Wood and Dane Co. in 1953, but d.b.h. was measured instead.

Yearly measurements of height growth of rooted cuttings and control seedlings are summarized in Table 1. No significant difference in height growth between seedlings and rooted cuttings has appeared. In the sample of 20 trees from the Wood Co. plantation, described below, rooted cuttings averaged 1.9 inches in diameter at one foot above the ground line, and seedlings averaged 2.0 inches. The trees ranged from 1.2 to 3.0 inches in diameter at this 1-foot point. All cuttings in the plantations have developed normal, upright trunks and fully symmetrical crowns which could not be distinguished in any way from those of the trees grown from seed.

Root development.—To ascertain the type of root system which developed under cuttings in the field, comparisons were made of the gross appearance of the root systems of cuttings and seedlings after 8 years in the Wood County plantation. Ten trees from cuttings and ten trees of seedling origin were sampled by choosing every fourth or every second tree of each group, respectively. The trees were dug out so that the central mass of roots was intact for a radius of at least one foot from the root crown. The top was cut off, soil washed away, and the root mass placed over a string grid of 4-inch squares to aid in mapping the root system. All roots one-fourth inch or over in diameter at the point of origin were mapped to scale to show (1) lateral distribution, and (2) vertical distribution. A numerical rating of the relative size of the root systems

[1]Approved for publication by the Director of the Wisconsin Agricultural Experiment Station.

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Thanks are due Eugene Herrling for preparation of the photographs.

FIG. 1.—Root systems formed by rooted cuttings after 8 years in a plantation. *A*. Root system with good lateral distribution. *B*. Root system with poor lateral distribution, dominated by the two main roots initially produced by the cutting.

was the total area traversed by all roots, expressed as the sum of all squares through which each root passed from its point of origin at the root crown to the margin of the grid.

Examples of both good and bad lateral and vertical root distribution were found among both rooted cuttings and control seedlings. Root systems formed by rooted cuttings after 8 years in a plantation are shown in Figure 1. The most extensive root system of all the trees was on a rooted cutting, where numerous additional roots had developed from the crown to give especially good lateral distribution (Fig. 1, *A*). More variation, however, was encountered among root systems of cuttings than of seedlings.

In comparisons of the lateral distribution of roots, the total area (number of squares) traversed by roots of rooted cuttings was slightly less than that coursed by roots of the seedlings, 604 vs. 649, respectively. Trees with both good and poor lateral distribution were observed in cuttings and in seedlings. The maps showing lateral spread were divided into four quadrants, and lateral spread into each was determined. "Weak" quadrants were those in which lateral root distribution was relatively poor. Six rooted cuttings had poor root distribution in at least one quadrant; whereas three seedlings had at least one "weak" quadrant. In another comparison, there were 8 "weak" quadrants in the lateral root spread of the cuttings, and 4 "weak" quadrants for the seedlings. Even in the "weak" quadrants there was generally some anchorage so that the possible susceptibility to windfall was not too great.

The lateral pattern of development of the root system of a cutting after 8 years in the plantation was influenced largely by the number of main roots initially formed by a cutting. The original main roots tended to dominate the basic pattern, particularly of lateral distribution, which ultimately developed (Fig. 1, *B*). Additional lateral roots usually developed after planting, however, so that a complete absence of roots in a given quadrant was rare. Root pruning of cuttings stimulated lateral root development. If the growing tips of the roots were clipped off at the time of transplanting from the cutting bed, two or more roots developed from the clipped roots of most of the cuttings. Root pruning was done again almost automatically when the cutting transplants were lifted for field planting.

An external factor in the development of unbalanced root systems was the care with which roots were spread out in planting. This appeared to be the reason for a few of the "weak" quadrants of seedling root systems, but was of little importance with the cuttings because of the stiffness and more-spreading habit of the main roots of the cuttings.

Seedlings and rooted cuttings exhibited greater differences in vertical than in lateral root distribution. The total area traversed on a vertical plane by roots of cuttings and seedlings was approximately the same, 339 vs. 345, respectively.

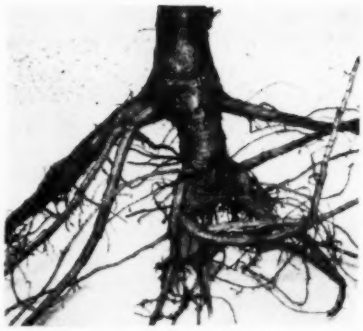

FIG. 2.—Root system developed by tree of seedling origin.

Differences in the proportion of roots in the various soil levels were determined by a count of the number of squares traversed in the vertical plane, and expressed as a percentage of the total area traversed by the entire root system to a depth of 18 inches. Thus, in the 0-6, 6-10, 10-14, and 14-18 inch soil depth classes, the proportion of the root systems of cuttings was 47, 41, 8 and 4 percent, and of seedlings, 26, 45, 22 and 7 percent, respectively. The cuttings had a greater concentration of roots in the top 6 inches of soil than did seedlings, but a smaller proportion in the 10-14 inch level.

Differences in vertical root-distribution patterns of cuttings and seedlings were primarily the result of the different types of root crowns characterizing the two groups. The root crown of the typical seedling was deeper and more elongated than the root crown area of cuttings, and roots of trees of seedling origin emerged at several different levels over a crown-length of approximately 6 to 8 inches (Fig. 2). Furthermore, roots of many of the cuttings had a tendency to emerge in an almost horizontal plane and to continue growth in that manner; whereas the roots of seedlings were more likely to emerge at an angle and, during early growth at least, to grow in a general downward direction. Although cuttings had a greater proportion of the main roots in the upper soil levels, individual roots grew just as deep as those of seedlings, and at a level of 18 inches there were approximately as many roots of cuttings as of seedlings.

Observations on feeding roots were made only incidentally to the study of the main roots. No major difference was observed. The amounts of growth by both cuttings and seedlings indicated that the root systems of the two groups were equal from the nutritional standpoint.

Discussion

It is not enough for a cutting to strike roots in the cutting bed. It must also develop into a tree with good growth and form characteristics. Except to raise some questions about the subsequent growth and development of rooted cuttings of conifers, the literature offers little on the subject. McCulloch (*3*) noted that in their third season in the field rooted cuttings of Douglas-fir were more branch-like than tree-like and had failed to develop a well-defined leader. Graves (*2*) observed that branch-like development was typical of plants such as Douglas-fir and yew. Cuttings from terminal shoots of yew yield plants with vertical central stems; whereas those made from side branches develop into plants of a spreading habit. However, all cuttings from trees of Thuja or Chamaecyparis, for example, develop into trees resembling the parents. Mirov (*4*) illustrated development of a rooted cutting of Monterey pine into a normal, well-formed tree, but expressed some doubt as to the subsequent development of rooted cuttings of ponderosa and eastern white pines. Doran (*1*) reported that small white pine from rooted cuttings were developing into trees of normal form after four growing seasons outdoors.

The observations recorded here give no justification for the fear that white pine cuttings might develop into poorly-formed trees. On the contrary, cuttings and seedlings, up to 8 years after planting, were indistinguishable in both type and amount of top growth. Such observations were consistent for over 600 rooted cuttings in plantations.

The pattern of subsequent root development of white pine cuttings admittedly was based on a small sample, since we did not wish to disrupt the growth pattern in the plantation too much at this time. From the sample that could be spared, however, it appears that, as cuttings grew older, their root systems approach the characteristic forms and development of those of normal trees and are adequate for normal nutrition and support.

The root development of a planted tree originating from a cutting might be improved through attention to details of planting. Root pruning, which stimulated lateral root development and is unavoidable during lifting from the transplant bed, could be systematized. Further, horizontal roots could be bent down when cuttings were transplanted, so that the roots would grow in a generally downward direction.

Summary

Comparisons of groups of rooted cuttings and seedlings up to 8 years after planting showed that both had developed normal upright forms, indistinguishable from each other by either type or amount of growth.

The root systems of cuttings were adequate for normal growth. As cuttings grew older, their root systems approached those of seedlings in form and development.

Root pruning of cuttings before outplanting in the field helped the formation of well-developed root systems.

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Coming Events

American Forestry Association

The annual meeting of the American Forestry Association will be held at the Multnomah Hotel, Portland, Ore., September 6-9.

Society of American Foresters

Annual meeting, Hotel Schroeder, Milwaukee 3, Wis., October 24-27.

National Watershed Congress

Statler Hotel, Washington, D. C., December 6-7.

Western Forestry and Conservation Association

The 45th Western Forestry Conference and the annual meeting of the Western Forestry and Conservation Association will be held at the Fairmont Hotel in San Francisco, December 7-10.

Fourth World Forestry Congress

Sponsored by United Nations Food and Agriculture Organization. New Delhi, India, December 4-17.

New England Section

The summer meeting of the New England Section will be held September 16 and 17 at Winnipesauke Farms, The Weirs, N. H., six miles north of Laconia on Lake Winnipesauke.

New York Section

The summer meeting of the New York Section will be held at Letchworth Park, September 9, 10, and 11.

Southwestern Section

The annual meeting of the Southwestern Section will be held at Taos, N. Mex., October 8 and 9.

Iowa State Anniversary

The 50th anniversary of the establishment of the Department of Forestry at Iowa State College will be celebrated at Ames on October 15 and 16.

Propagation of Sugar Maple by Vegetative Cuttings[1]

Stuart Dunn and Ralph J. Townsend[2]
University of New Hampshire, Durham.

A PROJECT on propagation of sugar maple by cuttings was started several years ago, for the purpose of ultimately developing a strain of trees with sap of high sugar content. The study would be based on cuttings taken from a few exceptional trees producing sap with a sugar percentage considerably above the average. There is considerable evidence that this type of performance is fairly consistent for certain trees (*1, 2, 5*). Thus, it may be to a large extent a genetic factor, although other factors, such as site and soil fertility, may have a bearing on the matter.

Early work on this project involved finding the best methods of gathering and handling the cuttings, substances effective for root stimulation, etc. Work by Snow (*3*) indicated that cuttings of current season's wood or green-wood cuttings would be the best type of material and this was confirmed by our results. Late June or early July were the best times for gathering under New Hampshire conditions. It soon became evident that moisture of the air around the foliage of cuttings was an important factor in keeping them alive; injury and death soon followed if the air was too dry. Beds of various types, including closed, opaque chambers with fluorescent light (*4*) were tried as means of achieving high humidity of the air around the cuttings; but with indifferent success for the most part as regards rooting percentages of the total tested. It was only by keeping a constant mist above the propagation beds that a fairly consistently sure method of rooting was evolved.

[1]Published with the approval of the director of the New Hampshire Agricultural Experiment Station as Scientific Contribution No. 167.

[2]Part of this paper is based upon a thesis prepared by the junior author in partial fulfillment of the requirements for the M.S. degree at the University of New Hampshire.

TABLE 1.—SUGAR MAPLE CUTTINGS IN CONSTANT MIST IN GREENHOUSE BED (SUMMARY FOR 1951, 1952, 1953)

Treatment	Number tested	Number rooted	Number callused	Percent rooted
Control	520	117	71	22
Indolbutyric acid 0.1 (*percent*)	424	123	77	29
Indolbutyric acid 0.5	450	106	50	23
Indolbutyric acid 1.0	126	25	5	20
Naphthalene acetic acid 0.1	160	34	13	21
Naphthalene acetic acid 0.5	144	20	15	14
Naphthalene acetic acid 1.0	90	10	6	11
p-chlorophenoxy acetic acid 0.1	124	25	14	20
p-chlorophenoxy acetic acid 0.5	32	10	7	31
B naphthoxy acetic acid 0.1	72	10	5	14
p-thiocresol 0.1	72	9	5	12
Total	2214	487	268	22(Av.)

Experimental Results for 1951, 1952, 1953

A well-drained ground bed with constant mist in a greenhouse was used for most of the propagation work. It was filled with sand and shaded both with nylon netting and white wash on the greenhouse roof above that. The nozzles for producing the mist were upright above the sand at regular intervals.

The cuttings were gathered by hand, or pole shears, the cut made well back from the part to be used, and brought to the laboratory for processing. In general the best cuttings were made from either terminal or lateral twigs (all greenwood) about 4 to 6 inches long. These should have fairly mature leaves, because those without adequate cutinization are too tender, and die and rot readily. All but two or three leaves per cutting were removed. Abnormally long, rapidly growing shoots, of the type called "water sprouts", usually do not make good cutting material. They are too pithy and probably low in carbohydrate. On some trees the right kind of cutting material is hard to find. On most of them it is not very abundant. This may be a handicap in trying out several variables in experimental work.

The rooting and callusing results for the three seasons are summarized in Table 1 according to growth regulator treatments. All treatments were by the so-called "quick-dip" method, in which the cut end was dipped momentarily in a 50 percent ethyl alcohol solution of the pure compound. This was found to be better than soaking them in more dilute solutions for longer periods. An exception was p-thiocresol, which was first dissolved in melted carbowax, then in water. The results of 29 percent rooted indicate that indolbutyric acid at 0.1 percent strength is about the best treatment to use, although a slightly higher percentage of rooting (31 percent) was obtained on relatively few cuttings with p-chlorophenoxyacetic acid. Some individual treatments with growth regulators produced rooting as high as 50 percent within small groups of cuttings. Data on callusing without rooting are presented also, but are probably not of very great significance, except as somewhat of an indication of physiological activity.

A marked clonal difference in rooting was observed, i.e., percentage of rooting in cuttings from individual trees was quite different. Records kept on four old trees showed that this performance was fairly consistent from year to year. One tree, producing sap of high sugar content, had a low record of rooting. This tree was declining in vigor. Another tree, not quite so high in sugar percentage of sap but very vigorous, had a high rooting percentage in cuttings.

Results for a final test of the closed chambers with high humidity and fluorescent light in 1951, confirmed previous records, that this is not as good a method as that of constant mist in open-air beds in a greenhouse. Higher light intensity gave better rooting than lower intensity. This was with two 40-watt fluorescent lamps per chamber compared to one lamp. Limited tests in 1953 with an outdoor bed of cheap construction and with mist from oil-burner nozzles indicated that this method is very promising. These nozzles gave a finer mist than any used hitherto. There was some indication that sawdust as a rooting medium has possibilities.

At the close of each rooting period, usually about the middle of August, each lot of cuttings was examined and the rooted ones retained for tests of various methods of prolonging their life and growth. In different years different methods were attempted—transplantation to a forest nursery bed, potting and storage outdoors in a cold frame covered with straw or with sawdust, potting and storage in a cool greenhouse, etc. All these attempts at carrying the rooted cuttings one step farther in their development were failures. In many instances they remained alive over winter but failed to bud out the next spring. More work is planned on this project with greater emphasis on trying to obtain further development of the cuttings after rooting.

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Ralph W. Hayes Retires as L. S. U. Director of Forestry

Ralph W. Hayes, director of the School of Forestry at Louisiana State University, Baton Rouge, has retired.

A graduate of Iowa State College where he received the B.S.F. degree in 1914, Mr. Hayes was first employed by a lumber company in Idaho, and then by the U. S. Indian Service as forester on various reservations in the West. For brief periods he was logging engineer for firms in Oregon and British Columbia.

RALPH W. HAYES

Having received the M.F. degree from Iowa State College in 1924, he then taught forestry for two years at Colorado Agricultural College. He went to Louisiana State University as assistant professor of Forestry in 1926, subsequently becoming full professor and director of the school.

Views from Institute of Forest Genetics, Placerville, California

Upper left—Institute quarters.

Upper right—Tree on left: *Pinus jeffreyi* × (*P. jeffreyi* × *P. coulteri*) Tree on right: *P. jeffreyi*. Age: 13.5 years.

Lower left—Tree on left: *P. contorta* × *P. banksiana*. Tree on right: *P. contorta*. Age: 13.5 years. Both are typical plants. Note abundant cone production on the hybrid.

Lower right—Lower line (connecting tops of trees): *P. jeffreyi*. Upper line: *P. jeffreyi* × (*P. jeffreyi* × *P. coulteri*). Age: 13 years. The hybrids which are highly resistant to the pine reproduction weevil (*Cyclindrocopturus eatoni*), have been planted on several national forests in California.

Photos: U. S. Forest Service.

Notes

BRIEFS OF FOREST TREE IMPROVEMENT WORK IN NORTH AMERICA BY REGION OR ORGANIZATION

Forest Tree Improvement Research in California

Forest tree breeding was first done in California late in the 19th century by Luther Burbank, who succeeded in crossing walnuts. In 1907, E. B. Babcock undertook a study into the origin of an oak-like walnut and demonstrated that it originated, not from hybridization between a walnut and an oak as was supposed, but through mutation. This analytical study, systematically conducted in the light of Mendelian principles, marks the beginning of work in forest tree genetics in the United States, if not in the world.

No further work was done in California until 1925 when James G. Eddy of Seattle founded the Eddy Tree Breeding Station at Placerville. Reorganized in 1932 as the Institute of Forest Genetics, this station was donated to the people of the United States in 1935, and it has since been operated by the U. S. Forest Service as a unit of the California Forest and Range Experiment Station.

Accomplishments

Aside from the works of Burbank and of Babcock, the main advances in California have been made by the Institute and its cooperators working exclusively in Pinus. Including about 90 species, this genus provides an enormous supply of genetic diversity with which to work and thus offers very favorable opportunities for synthetic breeding. Outstanding among the Institute's early accomplishments (before 1935) were the establishment at Placerville of the Eddy Arboretum containing about 70 species of pine, the development of an excellent nursery technique, and the production of 9 hybrids, one of which outgrows all pines native to the Sierra Nevada. Later accomplishments include the following:

1. Development of a highly effective technique for controlling pollination of pines under Sierra Nevada conditions.
2. Important contributions to tree breeding theory.
3. An analysis of the relation of seed size and seedling size to inherent vigor in pines.
4. A study of elevational variation in ponderosa pine.
5. A comprehensive study of the chemistry of pine oleoresins which, among other things, has shed light on the biosystematic relationships of the species and has suggested a plausible hypothesis to account for differences between various species in resistance to certain destructive insects.
6. Development of methods for inducing polyploidy in pines through application of colchicine.
7. Production of about 60 additional hybrids (F_1's, F_2's, backcrosses, and tri-species hybrids), some of which have performed well in nursery and field tests at Placerville and elsewhere. Two yellow pine hybrids have withstood forced attacks of insects and one white pine hybrid has resisted blister-rust infection in a test area over a period of 9 years.

Current Research

The Institute's experimental work falls into three main fields: (1) exploratory investigations, consisting of hybridization and selection; (2) mass-production studies, dealing with the methodology and economies of large-scale production of seed of promising hybrids; and (3) facilitating investigations, involving short-term studies in other fields (physiology, biochemistry, taxonomy, morphology, etc.) to aid the exploratory investigations and facilitate the practical application of their results.

Exploratory Investigations.—The investigations in hybridization and selection are aimed directly at improvement of the pines. For example, production of a particular hybrid is attempted, and if the hybrid is obtained, its economic potentialities are studied through performance tests in the nursery and in field plantings. In the course of such testing, or separately, various treatments (inoculation with pathogens, forced attacks by insects, etc.) may be applied by cooperating scientists.

The military maxim "time spent in reconnaissance is never wasted" applies as well in tree breeding as in warfare. The most prominent feature of the Institute's program is its pine-hybridization reconnaissance. This reconnaissance yields data on (1) the crossability of particular species and of hybrids; (2) the ease with which hybrids and their progenies may be obtained; (3) the inheritance of characters, and (4) the economic potentialities of the hybrids.

In this work, a cross is first attempted on a small scale without aiming at a specific location or use and without trying to select superior phenotypes as parents. An attempt is made, though, to avoid diseased or otherwise defective parents. Usually, a few pollination bags are placed on two or three trees of one species, and a mixture of pollen from several trees of the other species is used in making the pollinations. If sound seeds are obtained from the crossings, they are kept separate by seed-tree and the seeds from each tree are tested against the wind-pollinated seeds from the same tree. The results of such a procedure indicate what in general may be expected from other crossings between the species.

Several hybrids obtained in this reconnaissance have shown great superiority over one or both parents. No breeder, however, would be permanently satisfied with such

hybrids, great as their superiority might be, for they are usually made without the benefit of selection. The reconnaissance merely establishes logical points of departure in breeding pines for particular localities and purposes. The next step is to develop improved forms of the hybrids through genotypic selection of the parental stocks within the proper proveniences. Such selection will necessarily prove rather time-consuming. Fortunately, it may not be necessary to await its fruiting before reaping practical benefits from hybrids already obtained. It may be possible to gain substantial increases in profits through use of promising, but unimproved, hybrids. Some of the hybrids are so outstanding in performance that the feasibility of producing them in abundance merits special investigation.

Mass Production of Hybrids.—Unimproved hybrids and other products of breeding can be used safely without thorough testing provided they are interplanted with the parental species native to the area on which they are to be grown. The economic feasibility of such a course, however, depends on the total increase in yield from the hybrids in relation to the cost of seed-production carried forward at compound interest. Will the seed from, say, a 1000-pollination-bag job produce an increase in yield sufficient to pay for the cost of the seed and also return a profit to the forest owner? It depends on various factors: site quality, rotation, stumpage value, number of hybrids planted per acre, relative performance of the hybrids, number of seeds obtainable per bag, and cost of producing the seed. The immediate concern of the Station is with the last two factors.

Although very encouraging data on those points have already been obtained for some hybrids, they are not deemed to be representative of the actual possibilities. The Station therefore plans to conduct annual mass-production tests of various hybrids.

The nursery phase of the work will terminate the mass-production test but not the use of the hybrids, which will be planted out in large interplantings. These investigations will thus serve several purposes: they will yield data bearing on the feasibility of producing the hybrids for practical use and they will provide materials for large field tests that will supply data on performance. Moreover, both increased yields and valuable seed will be obtained in the event that a hybrid proves successful.

Facilitating Investigations.—Studies which aid the breeding program are conducted by the Institute's staff and by collaborating agencies and scientists in cooperation with the Institute. Current studies by the Institute's staff include the pine oleoresin study to which reference has been made; a study of the distribution and variation of the ponderosa pine complex; and experiments in vegetative reproduction. The first of these studies is being conducted with the aid of a grant from the Rockefeller Foundation, and the second is supported by a grant from Fred Searls, Jr. of New York. An investigation into the biochemical aspects of resistance to white pine blister rust is soon to be started.

The Station's Division of Forest Insect Research is conducting studies to determine the nature of resistance to various bark beetles. The outcome of these studies, which are now well advanced, will have highly important bearings on the problems of breeding for resistance to insects.

Research in various other scientific disciplines is needed to broaden the Station's pine-improvement program and accelerate application of its results. Physiological and biochemical investigations are needed, particularly on the biology of reproduction; and studies of the cytology, embryogeny, and taxonomy of numerous hybrids await attention.

F. I. RICHTER
Forest Geneticist, California Forest and Range Experiment Station, Berkeley.[1]

[1]Maintained by the Forest Service, U.S. Dept. Agric., in cooperation with the University of California.

Forest Tree Breeding in Canada

The chief aim of forest tree breeding in Canada is to serve the needs of artificial regeneration and to supply seed or plant materials that, from a genetic standpoint, are best suited for this purpose. The tree breeding activities are closely linked with forest tree planting. From 1939 to 1952, all forest tree breeding work was carried out in cooperation with the Subcommittee on Forest Tree Breeding of the Association Committee on Forestry of the National Research Council of Canada. In 1952, the Associate Committee on Forestry was disbanded and the director of the Forestry Branch, Canada Department of Northern Affairs and National Resources, assumed the responsibility for the activities of the Subcommittee which was reorganized under the name of Committee on Forest Tree Breeding.

Work in British Columbia is carried out by W. A. Porter and A. L. Orr-Ewing. Mr. Porter is employed by the Canada Department of Agriculture in Victoria, B. C. and is selecting western white pine for resistance to blister rust. Seemingly resistant trees in the more accessible coast forest are located in areas with heavy infection and scions from these are grafted on seedling stock imported from Montana. The grafts are being tested in a disease garden with Ribes, in a climate that is favourable to natural infection. Materials from Dr. A. J. Riker in Wisconsin and R. T. Bingham in Washington, as well as from eastern Canada, are included in these tests. Lately, materials from the interior of British Columbia are also being tested. Work with selection of Douglas-fir for possible resistance to *Rhabdocline pseudotsugae* is being started. Mr. Orr-Ewing is employed by the B. C. Forest Service and is studying flowering and fruiting of Douglas-fir as a basis for establishing seed orchards.

Work in Saskatchewan is chiefly concerned with the production of

superior tree and shrub materials for shelterbelts and windbreaks. Dr. W. H. Cram at the Forest Nursery Station, Indian Head, Sask., operated by the Canada Department of Agriculture, is working with Caragana, spruce, Scotch pine, and poplars. In Caragan, studies are under way in vegetative propagation, selfing and cross-compatibility within the species *C. arborescens*. Variation in rooting capacity of stem cuttings has been observed between clones and after application of bottom heat, fungicides and growth hormones, as well as with date of collection. Self-compatibility and cross-compatibility appear to be governed by incompatibility genes in agreement with the oppositional theory. In Scotch pine, the work thus far has been confined to nursery observations of one-parent progenies. The parent trees have been raised from seeds of different geographic origin and are grown at Indian Head. In spruce, seed germination of Colorado spruce after cold water pretreatment and stratification are being compared. Seed treatments with various fungicides, to control damping-off, are under way. In poplars, rooting capacity from stem cuttings and general adaption to prairie conditions of various cottonwood × Russian poplar seedlings are being evaluated, using the clone Northwest poplar as a standard of comparison.

The Forestry Branch, Canada Department of Northern Affairs and National Resources, is carrying out forest tree breeding at the Petawawa Forest Experiment Station, Chalk River, Ont., and the Acadia Forest Experiment Station, near Fredericton, N. B. Mr. M. J. Holst is in charge of tree breeding at the Petawawa Station. Work is under way mainly with spruce and hard pines. Provenance tests have been started with the three native spruce species and with Norway spruce. In white spruce and Norway spruce some strain test plantations have been established by C. Heimburger in the late thirties and early forties. These are being followed by growth measurements and other observations, and have recently been supplemented with much new material. Natural and artificial hybrids of black spruce with red spruce are under observation. Contact has been made with Canadian Pulp and Paper Association for the selection of superior phenotypes and cooperation in provenance tests with white spruce on the limits of member companies within the Great Lakes—St. Lawrence Forest Region. By means of such provenance tests it is hoped to gain insight into the genetic composition of natural stands, especially in respect to clinal variation in response to climate and soil conditions and in terms of yield, including wood density. In Norway spruce, adaptation to climate and resistance to the white pine weevil are under investigation. Hardy and slender types, apparently highly resistant to the weevil, have been found and are being propagated. Artificial hybrids and self-pollinations in white and Norway spruce have been produced to determine the breeding value of single trees. Seeds of 33 provenances of white spruce, mostly from Ontario and Quebec, of 14 provenances of red spruce ranging in origin from North Carolina to Quebec and of 11 provenances of Norway spruce collected from the best known stands in Europe have been assembled. One-parent progenies of 46 extremely broad and slender types of white spruce are under observation, to study the inheritance of growth form in relation to yield. In hard pines, tests are under way with 18 provenances of red pine and seeds of various jack pine provenances are being assembled for similar tests. The analysis of natural populations follows the same principles as in spruce. One -parent progenies of both pine species are under trial and the breeding value of single trees is further being determined by means of artificial hybridization and selfing. Good results with induction of flowering in young red pine have been obtained after the application of ammonium nitrate and after partial girdling near the ground. Resistance to the European pine shoot moth is one of the aims of red pine breeding and this is sought by means of hybridization with related species. This project is being carried out in cooperation with C. Heimburger. Satisfactory methods of greenhouse grafting and outside grafting of spruce and hard pines have been worked out. Lately, fall grafting has been attempted, to make scion collection coincide with seed collection. Production of rootstocks suitable for the induction of early and abundant flowering has been successful in spruce and hard pines. Limited work with white pine, Douglas-fir, larch, and poplars is also under way.

At the Acadia Station Mr. H. G. Mac Gillivray is initiating work in New Brunswick. A search for superior stands and individuals of spruce and balsam fir has begun, as well as the assembling of materials for provenance tests. Cotyledon numbers in seedlings of balsam fir and spruce are higher in southern provenances than in northern. As a rule, red spruce seedlings have more cotyledons than black spruce from the same general locality. A balsam fir that apparently is resistant to the spruce budworm has been found.

The Ontario Department of Lands and Forests is conducting provenance tests with white pine, red pine, jack pine, Scotch pine and Corsican pine under the direction of A. J. Carmichael at the Provincial seed extraction plant in Angus, Ont. Usually, about a dozen provenances are included in each test, covering the entire Province. The tests are tied in with the 3 main climatic regions where seed collection and reforestation are of importance. Forest tree breeding is being carried out at the Southern Research Station, Maple, Ont., under the direction of Dr. C. Heimburger. Work with white pine, aspen poplars and hard pines is under way and is, in part, supported by grants from the Research Council of Ontario. In white pine, the aim is to select and produce strains having a high degree of resistance to blister rust and a

favourable reaction pattern in respect to weevil injury, and satisfactory growth rate and growth form. The breeding program is concerned mainly with the testing, evaluation and propagation of promising native white pine materials. It deals also with white pine of other regions and of other kinds in order to introduce valuable characteristics from these into the production of superior strains. The main efforts thus far have been directed toward the collection of breeding materials and their testing and evaluation. The acquisition of new materials has been chiefly in the form of grafts. Grafting is also used in vegetative propagation of any promising materials. Thus far, 432 clones of white pine and related species have been assembled in this manner with a total of 8,023 successful grafts. Seedling populations of 24 provenances have been set out in 11 test plantations, mostly in southern and central Ontario, and comprising about 198 thousand plants. A small number of populations have been raised as grafts from scions obtained in localities where it has not been possible to obtain seeds. A limited amount of hybridization is being done with selected individuals of native and exotic species, with the aim of exploring the crossabilities between species and utilize successful crosses for breeding work. Some of the older grafts are beginning to flower and are being utilized for this purpose to an increasing degree. All white pine materials are being inoculated with blister rust every year. Black current bushes are growing in a lath house to supply strong shoots with rust for inoculation. Outside grafting was first tried in 1948, was further perfected in 1949 and 1950, and makes it possible to graft white pine on established stock in the nursery and in plantations. Grafting of scions from seedlings and young trees onto low side branches of old trees has been started, to induce early production of pollen. The early production of female flowers is favoured by scion collection from the upper parts of flowering trees and by planting the grafts in dwarfing boxes, designed by I. B. Lucas of Markdale, Ont., to induce early flowering in dwarf fruit trees. The propagation of the most promising materials for the establishment of seed orchards has been started in 1953, after intensive testing for resistance to blister rust in previous years. An exchange of breeding materials with Dr. A. J. Riker of Wisconsin, R. T. Bingham of Washington and W. A. Porter of British Columbia is in progress. The breeding for resistance to blister rust is being coordinated and kept up-to-date by the Blister Rust Control organization of the U. S. Forest Service which receives and distributes reports from workers with blister rust in U. S. and Canada.

In aspen poplars the aim is the production of strains with rapid growth, resistance to several important diseases and capability of growing in forest plantations in southern Ontario, and easy propagability from stem cuttings. This is being achieved through hybridization of various aspen species with silver poplar. A large collection of silver poplars has been assembled, from native habitats in the Mediterranean region and of planted materials from other parts of Europe and in North America. Collections of native and exotic aspen species have also been assembled and numerous crosses made between silver poplar and aspens, and between different aspen species. Silver poplars with good rooting capacity from stem cuttings have been found, and others of very good growth form and growth rate. Aspen materials that do very well in southern Ontario have also been assembled and produced by hybridization. Aspen breeding is at present subdivided into three phases: (1) mass production of the most promising hybrids from seed, to satisfy the growing demands of the wood using industries for planting stock and our requirements for test plantations under different conditions, (2) breeding of early-flowering stocks for grafting, to induce early flowering in promising breeding materials, i.e., the production of better tools for future breeding work and (3) continuation of the long-term project of incorporating rooting capacity and other desirable characters of silver poplar into aspen hybrids, based on experience gained from phase (1). Precocious types of both native aspen species have been found in southern Ontario and are being used in phase (2).

In hard pines the problem was at first to increase seed production in young plantations of red pine. Heavy thinning and partial girdling have given very promising results in this respect. In recent years, cooperation has been initiated with Mr. Holst of the Petawawa station in breeding for resistance to the European pine shoot moth, within the Lariciones section. As it probably will be difficult or impossible to achieve this through selection within red pine or Scotch pine alone, interspecific hybridization offers more promise. A collection of breeding materials is being assembled and some crosses made within this group every year. Rootstocks suitable for the induction of early and abundant flowering are available.

Mr. J. A. C. Grant is undertaking studies on photoperiodic response of aspen poplars and hard pines at the University of Toronto, with support from the Research Council of Ontario. These studies are integrated with the work at Maple, Ontario, and have a direct bearing on the use of breeding materials of these species from latitudes with photoperiods differing appreciably from those obtaining at Maple.

Dr. A. W. S. Hunter is working at the Central Experimental Farm in Ottawa, Ont., and at the Dominion Experimental Station, L'Assomption, Quebec, in breeding for resistance to the Dutch elm disease. One hybrid between *Ulmus pumila* and *U. americana* has been produced and experiments in vegetative propagation of elm are under way. It has been possible to produce a tetraploid *U. pumila* by colchicine treatment of germi-

nating seeds. Sterile Ribes resulting from a cross between blister rust susceptible black and red currants have been produced, for possible use in field testing of white pine.

Dr. R. J. Moore is carrying out cytogenetic studies in Caragana at the Central Experimental Farm in Ottawa, to provide basic information for the work of Dr. Cram at Indian Head, Sask. Dr. L. Chouinard started last year to give lectures in forest genetics at the School of Forestry, Laval University, the first of this kind in Canada. During this summer a survey is planned of the variation in black spruce and red spruce in Quebec, as well as in jack pine.

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The Committee on Southern Forest Tree Improvement

On January 9 and 10, 1951, at a meeting called by J. Herbert Stone, Regional Forester, about 70 foresters and others interested in tree improvement gathered in Atlanta, Georgia. This South-wide meeting helped crystallize a growing feeling that southern forestry was overlooking prospects for inestimable advances by giving only passing attention to the principles of genetics. The need for a permanent organization to guide and develop thinking and understanding of tree improvement was recognized. I. T. Haig and C. A. Connaughton, directors of the Southeastern and Southern Forest Experiment Stations, respectively, were called on to appoint a Committee on Southern Forest Tree Improvement, to promote interest and activity in this field.

As originally appointed the Committee included:

Agency	*No. of Representatives*
U. S. Forest Service	
Experiment Stations	3
Region 8 Office	1
State Forest Services	2
Pulp Companies	2
Tennessee Valley Authority	1
Bureau of Plant Industry	1
Forestry Schools	2

After two years the Committee reduced the Southeastern Forest Experiment Station representatives from two to one, increased the number of school representatives to three, and added two representatives from the lumber industry. In December 1953 it added a forest entomologist. The Committee at present has fifteen members representing a wide range of interests in ten states from Texas to North Carolina.

The Committee is not formally organized and has no funds of its own or means for collecting and disbursing funds. However, it has associated itself formally with the Forest Genetics Research Foundation, organized under the General Non-profit Corporation Law of California, and has one member on its Board of Directors. Tree improvement activity has been further integrated by this association.

The guiding purposes of the Committee are defined as follows:

1. To advise and assist those interested in the improvement of southern forest trees in arranging and conducting research and development programs.
2. To provide a clearing house for information on forest tree improvement.
3. To provide for or assist in coordination in the conduct of a Southwide program of tree improvement research and development.
4. To foster and encourage the advancement of knowledge of southern tree genetics.

Compilation of information and instructional material has been a major activity. Nine publications have already been prepared through Committee cooperation and issued by the U. S. Forest Service, Region 8, the Southern or Southeastern Forest Experiment Stations, or T.V.A. Regardless of the issuing agency, Committee reports are numbered consecutively and all previous titles are listed in each successive publication.

A newsletter on current developments is distributed to a mailing list of about 400 interested persons. Successive issues of the newsletter have been prepared by Committee members or others associated with the Texas Forest Service, T.V.A., N. C. State College and the University of Florida. Keith Dorman of the Southeastern Forest Experiment Station will prepare the next newsletter, to appear in the fall of 1954.

The keen interest in tree improvement shown at the 1951 South-wide meeting encouraged the Committee to sponsor a second South-wide meeting in Atlanta on January 6-7, 1953. The program included current developments and progress in tree improvement and recent advances in technique and application. Plans are now being made for a third South-wide meeting to be held in New Orleans in early January, 1954. D. A. Anderson of the Texas Forest Service is in charge of program and Director Philip A. Briegleb of the Southern Forest Experiment Station in charge of local arrangements.

The Committee has been effective in helping to initiate tree improvement research and in the application of tree improvement practices.

A major accomplishment has been the establishment of the Southwide Pine Seed Source Study under the direction of a Subcommittee headed by Philip C. Wakeley of the Southern Forest Experiment Station. The 66 test plantations of the study include longleaf pine seed from 14 distinct geographic sources, slash pine from 6 sources, loblolly pine from 15 sources, and shortleaf pine from 15 sources. Located in 16 states, from Pennsylvania and New Jersey south to Florida and west to Texas and Oklahoma, the plantations include 1,844 1/10-acre plots that by 1954-55 will contain about 223,000 trees. The study is supported in part by a grant to the Committee from the Forest Genetics Research Foundation.

In 1951, Carl Ostrom, Chairman of the Committee, proposed to Director C. C. Murray of the Georgia Agricultural Experiment Station that a regional project, supported by Bankhead-Jones Title 9-B funds, be established in the South. A project, S-23 Southern Regional Project *Forest Tree Improvement*, has now been approved. Six southern States and the U. S. Forest Service are represented on the Technical Committee. Alabama and Georgia have submitted studies under the regional project.

Efforts of the Committee have contributed materially toward the current trend among state forestry agencies in the South to identify the source of seed used in nursery planting and to distribute the planting stock on the basis of seed source.

Action on the part of the Committee helped effect the appointment of an Associate Editor for Forest Genetics and Artificial Regeneration on the Journal of Forestry staff and establish a Committee on Forest Tree Improvement in the Division of Silviculture of the Society of American Foresters.

Tree Improvement research is now being conducted in the South by the two U. S. Forest Service experiment stations; by several state agencies, notably the Texas Forest Service and the Mississippi Forestry Commission; by a number of private companies; by the T.V.A.; and by several of the accredited schools of forestry. The Committee has assisted in this development by stimulating interest, preparing guideline materials, assembling information, and providing avenues for an interchange of ideas.

CLEMENS M. KAUFMAN
Chairman, Committee on Southern Forest Tree Improvement, University of Florida, Gainesville.

Forest Genetics Research Foundation

The Forest Genetics Research Foundation was instituted in 1951 by a small group of men impressed with the possibility of increasing timber production by application of the principles of genetics to forest tree improvement. Their interest and generosity resulted in the legal establishment of the Foundation as a non-profit corporation with its five original sponsors as officers, all of whom are still serving as directors: James G. Eddy, Pacific Northwest lumberman and founder of the Eddy Tree Breeding Institute which later became the Institute of Forest Genetics; Dr. Ernest B. Babcock, emeritus professor of genetics, University of California; Robert H. Dart, California manager, Simons and French Company; C. M. Goethe, farmer-philanthropist, Sacramento, California; and Dr. Howard E. McMinn, professor of botany, Mills College, Oakland, California. The Foundation now has a board of 30 directors from all parts of the country, consisting of scientists, conservationists, bankers, and representatives of the lumber and pulp and paper industries.

The Foundation's general objective is to serve as a stimulus to research and education in forest tree improvement, particularly in its more technical aspects. More specifically, it proposes to make grants-in-aid, where needed, to qualified institutions and individuals for research projects in forest tree improvement. It has no intention of establishing new laboratories or other research facilities, preferring to work cooperatively with universities and other institutions having competent personnel and adequate facilities. The Foundation can also stimulate research by sponsoring conferences and seminars on topics of special interest to technical workers throughout the country; by encouraging and assisting in the development of interregional and international projects where common interests exist; and by assisting in development of special media for publication of research results. In the field of education the Foundation's first activity will be to grant doctoral and post-doctoral fellowships to carefully selected men, to help meet the impending need for a greater number of workers thoroughly trained in the plant sciences fundamental to forest tree improvement.

Funds for all of these activities will be secured by voluntary contributions. Thus far contributions have been received from wood-using industries, interested individuals and other foundations.

Before considering the Foundation's plans in more detail it will be well to make clear the definitions for several terms and the relationships among them. In this discussion the term *forest tree improvement* is defined as that part of silviculture dealing with the production of better forest trees. It includes a wide range of practices, among the simpler of which are such undertakings as selection of the best trees in a stand to serve as seed trees for natural regeneration. Forest tree improvement also includes the complex undertaking generally termed *forest tree breeding*, the study and practice of forest tree improvement by artificial production of new tree forms developed to meet the requirements of special uses and particular environments. Finally, the successful practice of forest tree breeding depends directly upon the science of *forest genetics*, the special application of the laws of genetics to the breeding of improved forest trees.

To accomplish its purpose, and despite the narrower connotation of its name, the Forest Genetics Research Foundation proposes to support research projects in any

part of the field of forest tree improvement, with first priority given to studies in forest tree breeding and forest genetics. Operating in so broad a field the Foundation must, of necessity, establish policies which will serve as guide lines in selection of projects for support. Obviously, the first of these policies is that a clear showing of need for assistance is necessary. A basis of selection beyond this point can be found only in the stage of development of forest tree improvement at the time decisions must be made.

At the present time forest tree improvement work, as yet mostly in the research stage, is under way in most of the commercial forest regions of the United States, by numerous public and private institutions. As the studies in each region increase in number and diversity they tend to form a program similar in pattern to that in each of the other regions. This similarity in regional plans, which is natural and logical, is so marked as to permit the formulation of a generalized regional program of forest tree improvement, upon which a majority of the technical workers concerned would agree, with allowance for differences in terminology and emphasis upon the program's parts. The attempt made here to outline such a program is in no way original; it is merely a bringing together of the ideas of numerous technical workers as given in publications and informal discussions. The ten items in the program are offered as a logical but not a chronological series. Greatest progress would be made if a number of them were undertaken simultaneously.

A Generalized Regional Program of Forest Tree Improvement

1. Agreement among foresters on specifications of tree superiority for each commercial species.

2. Selection and protection of superior seed trees where natural regeneration is desired.

3. Selection and reservation of stands containing high proportions of superior trees for seed production. To secure best results this should include roguing out of all inferior trees in the stand.

4. Seed source and racial studies to identify best seed sources and races for planting in specific localities and for breeding stock.

5. Selection of superior trees and those possessing special characters of value, even if generally inferior, for breeding stock.

6. Seed progeny and clonal tests of trees selected for breeding stock, to determine if their superior characters are hereditary or are the effect of environment.

7. Breeding, to produce new forms superior for use in certain environments or for special uses, by inter- and intra-specific crosses.

8. Development of a system of seed certification, for protection of both seller and buyer of superior seed.

9. Development of methods for establishment and operation of seed orchards or other procedures for mass production of superior seeds, in order that seed supplies of superior forms will be regularly available at a reasonable cost.

10. Prosecution of various special studies in physiology, cytology and genetics to provide knowledge needed in the preceding steps.

The last item in this program needs fuller explanation. A number of studies in the field of physiology, cytology and genetics have been proposed by technical workers in forest tree improvement because their experience shows them the need for information to be secured only by investigations of this kind. The proposals pertain to such things as vegetative propagation, flowering, genetic variability, growth and other subjects of a similar nature. Their results would be put to immediate practical use in forest tree improvement. They are all of a highly specialized nature, demanding knowledge of special disciplines to a degree not usually possessed by foresters. In another sense they are general in nature in that they seek basic information applicable to all genera and species of forest trees, to be applied locally in solution of local problems.

With the development of regional programs, at least generally similar to that given here, drawing of the Foundation's guide lines for selection of research projects to support becomes easier. In view of its nation-wide interest it would support projects included under Item 10 in the generalized regional plan, since the results of these projects should be widely applicable. By reason of its special interest in the more technical phases of forest tree improvement it would give high priority to Items 4 to 7. However, projects under other items might be supported where necessary to maintain a balanced program in one of the forest regions.

The Foundation's general program is implemented through its board of directors, an executive committee of the board, an executive vice president and four regional vice presidents, each selected for his special knowledge of part of the country. Another important part of the Foundation's organization is a technical committee composed of four board members recognized as leaders in their respective fields of plant science. This committee will be responsible to the board of directors for making research and educational grants.

The way in which the Foundation's policies work out in application is exemplified by the two research grants thus far made. In accordance with the wishes of a donor to the Foundation, a grant was made to the Institute of Forest Genetics at Placerville, California, for a racial study of ponderosa pine and closely related species (primarily those with which ponderosa pine readily hybridizes.) The project pertains to a group of pine species of high value in eleven western states and clearly fits into a regional program of tree improvement for the Far West.

The second grant made by the Foundation was to assist the Southwide Pine Seed Source Study, sponsored by the Committee on Southern Forest Tree Improvement, in a well planned and conducted study, regional in nature and of undoubted value to forest

tree improvement over a wide area.

Projects such as these are clearly within the Foundation's field of interest in that they constitute logical steps in the orderly development of forest tree improvement knowledge in the several regions of the United States.

STEPHEN N. WYCKOFF
Executive vice president, Forest Genetics Research Foundation, Berkeley, Calif.

The Institute of Paper Chemistry

The research program of the Institute of Paper Chemistry at Appleton, Wis., was recently broadened by initiating investigation in forest tree genetics and breeding. Dr. Philip N. Joranson joined the Institute staff to be responsible for direction of this program. Work which he had previously been carrying on while on leave from Beloit College will be continued and intensified at the Institute. This involved an investigation of the possible utility of polyploid heredity as a practical means of lengthening the fiber and enhancing the growth rate of aspen.

Related studies in aspen will eventually supplement this first study and the Institute is contemplating attention to other species also. In the beginning, both fundamental studies and breeding work will be focused on problems associated with the Lake States region.

The program in tree improvement will be pursued in cooperation with various other projects at the Institute, with other tree breeding centers and coordinating groups, and with agencies concerned with soils, diseases, insects, and forest management. It is designed with the aim of gaining insight into the genetic behavior of species which are important sources of pulpwood, and to produce improved growing stock for pulpwood production.

Forest Tree Improvement Work in the Lake States

Forest tree improvement work in the Lake States in a sense began before 1900 when tests of the adaptability of several exotic tree species were included among some of the early forest plantings. However, planned experiments to determine the variation within a forest tree species did not begin until 1928, when Carlos G. Bates of the Lake States Forest Experiment Station began a study of red pine seed sources. This was followed during the ensuing 25 years by other forest tree improvement research at the Station, the state universities and colleges, and forest industries.

Forest tree improvement is of special interest in this region because of (1) the large acreage of land (nearly half the total area) suitable only for forest, (2) the presence of 9 to 12 million acres in need of planting, (3) the demands of a relatively harsh climate (hot summers, cold winters, rather short growing seasons, and fairly low precipitation), (4) the numerous insect enemies of important tree species, and (5) serious diseases, such as the white pine blister rust, which limit the growing of certain species.

What Has Been Done

Two general types of forest tree improvement work have been conducted in the Lake States: seed source studies and tree breeding projects. In very brief terms the status of this work is as follows.

Seed Source Studies.—In 1928, only 5 years after its establishment, the Lake States Forest Experiment Station began a study of red pine seed sources. This was followed by work on other species by a number of agencies as follows: (1) red pine (*Pinus resinosa*), some 170 sources, Lake States Station and the Nekoosa-Edwards Paper Company[1]; (2) Scotch pine (*P. sylvestris*), some 40 sources, Lake States Station and University of Michigan; (3) jack pine (*P. banksiana*), some 100 sources, University of Minnesota, Lake States Station, Nekoosa-Edwards Paper Company, and with cooperative assistance of State Conservation Departments of Minnesota, Wisconsin, and Michigan; U.S. Forest Service, North Central Region; Burnett and Marinette Counties, Wisconsin; Mosinee Pulp and Paper Company, and the University of Michigan; (4) ponderosa pine (*P. ponderosa*), 11 sources, Lake States Station, and University of Michigan; (5) Norway spruce (*Picea abies*), 18 sources, Lake States Station, (6) blue spruce (*P. pungens*), 14 sources, University of Minnesota; (7) white spruce (*P. glauca*), 6 sources, Lake States Station; (8) European larch (*Larix decidua*), 11 sources, Lake States Station; and (9) green ash (*Fraxinus pennsylvanica*), 39 sources, Lake States Station.

These studies vary in scope, intensity, and the time they have been under way, but they have already demonstrated racial variation in red pine, Scotch pine, jack pine, ponderosa pine, white spruce, Norway spruce, and green ash. As they develop and are supplemented by other research these studies will continue to yield results of increasing value.

Tree Breeding.—Probably the first planned forest tree breeding activity in the region was an unsuccessful attempt in 1928, at the Upper Peninsula branch of the Lake States Station, to cross-pollinate between bird's-eye maples (*Acer saccharum*). In 1935 the University of Wisconsin began a project on breeding forest trees for disease resistance. This has been followed by work on several species by a number of agencies as follows: (1) blister rust resistance of white pine (*Pinus strobus*), some 200 selections, University of Wisconsin; (2) fast growing, hardy poplars (*Populus* spp) more than 400 selections and hybrids, University of Wisconsin, Lake States Station,

[1]The status of work at agencies other than the Lake States Forest Experiment Station is based on reports included in "Proceedings, Lake States Forest Genetics Conference, March 31-April 1, 1953," Miscellaneous Report No. 22 of the Lake States Forest Experiment Station, 83 pp. (Processed).

University of Minnesota, Michigan State College, and Institute of Paper Chemistry; (3) developing hybrids between jack pine and lodgepole pine (*Pinus contorta*), several hybrids, Nekoosa-Edwards Paper Company, and University of Wisconsin; and field-testing similar hybrids developed by the Institute of Forest Genetics, 5 hybrids, Lake States Station; (4) testing hybrids between eastern white pine (*P. strobus*), and western white pine (*P. monticola*) developed at the Institute of Forest Genetics, 5 hybrids, Lake States Station; (5) selection by progeny tests of superior trees of native and introduced pines, spruces, larches, firs, and aspens, more than 500 selections, University of Wisconsin; (6) testing methods of vegetative propagation and inducing precocious flowering, University of Wisconsin; (7) finding elms (*Ulmus pumila*, *U. japonica*, *U. campestris*, and *U. parvifolia*) resistant to Dutch elm disease and pholem necrosis and hardy in the region, University of Minnesota; (8) the development of hardy nut-producing trees, several selections and hybrids, Michigan State College; (9) testing of Japanese chestnut (*Castanea crenata*), and Chinese chestnut (*C. mollissima*) and its hybrid with American chestnut (*C. dentata*), numerous selections and some hybrids, University of Michigan and Michigan State College; (10) selection of ponderosa pine from five localities for resistance to a rust fungus tentatively identified as *Cronartium cerebrum*, University of Michigan, and (11) selection of Norway spruce for resistance to the eastern gall aphid (*Chermes abietis*), University of Michigan.

Many of these studies are still too young to yield valid results. They have, however, (1) brought to light more than 30 white pine selections highly resistant to white pine blister rust, (2) illustrated the unsuitability of a number of hybrid poplars for this region, and (3) indicated promise for several native poplar selections and a few hybrids.

Lake States Forest Genetics Conference

In response to the growing interest in forest tree improvement in the region, the Lake States Forest Experiment Station sponsored a conference held at Eagle River, Wisconsin on March 31 and April 1, 1953. This conference was attended by 56 foresters, entomologists, and biologists from the colleges and universities, state conservation departments, forest industries, and federal forestry agencies of Minnesota, Wisconsin, Michigan, and also some representatives from Ohio, Ontario, Massachusetts, and California. This meeting provided an opportunity (1) for those engaged in forest tree improvement research to report briefly on what they had done and what they had learned, (2) for those interested to learn the status of such research in the Lake States, and (3) for interested people to point out problems needing study.

The Lake States Forest Tree Improvement Committee

Out of the Lake States Forest Genetics Conference there developed the Lake States Forest Tree Improvement Committee, the purpose of which is "to encourage and coordinate forest genetics activities in this region." The committee of nine was selected to represent the subject matter interests and agencies concerned in forest genetics work. It consists of a representative each from: the Minnesota, Wisconsin, and Michigan Conservation Departments; the Nekoosa-Edwards Paper Company; Michigan State College; the Universities of Minnesota, Michigan, and Wisconsin; and the Lake States Forest Experiment Station.

The committee, with the addition of seven well-qualified men outside its membership, has been divided into four temporary subcommittees with the following purposes: (1) to develop uniform seed collection zones for the Lake States, (2) to develop guides for the selection of superior stands and trees for the principal forest tree species of the Lake States, (3) to prepare a bibliography on forest genetics for the Lake States and a directory of forest genetics activities in the Lake States and adjacent regions, and (4) to develop a list of projects suggested for study to aid in the genetic improvement of Lake States forest trees. Each subcommittee has in preparation a report which, after suitable review, will be issued as a guide.

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Forest Tree Improvement Work in the Northeast

The Northeast is rich in exotic trees; early botanists began making Philadelphia a center of introduction fully 200 years ago. Since then, natural selection has indicated which exotics are adapted to our climatic conditions. This heritage of mature specimen trees is a most valuable foundation for modern forest tree improvement.

Racial Tests and Individual Tree Selection

The earliest provenance tests in this region were started in 1924 when H. I. Baldwin, who had become interested in such tests in Sweden, brought back a few sample lots of seed to the New York State Conservation Department for tests. Since 1927 additional tests have been started in New England, and the New York State Conservation Department has started seed-origin tests with 10 exotic and native species. More recently provenance studies with Douglas-fir and Scotch pine have been started in Pennsylvania.

One of the oldest and most complete collections of larch species and hybrids in forest plantations is located at Cooxrox Forest near Stephentown, N. Y. Here David B. Cook has been planting larch of known as well as of unknown and doubtful origin for the past 20 years.

[2]Maintained by the Forest Service, U.S. Dept. Agric., in cooperation with the University of Minnesota.

The search for inherently high-sugar-producing trees of the sugar maple dates back at least 15 years. At present the most intensive genetics research on this problem is going on at the University of Vermont, and at the Hopkins Experimental Forest at Williamstown, Mass. It is most encouraging that in their sugar-bush management the maple sugar producers themselves have been testing their trees to favor the individuals with the highest percentage of sugar.

Research on racial differences and individual tree selection has lagged in this region where reforestation has not been of paramount importance. Recently, however, interest in reforestation has been increasing; and it now appears that evaluation of the literally hundreds of acres of plantations of known origin may provide information on racial variation that could be put to immediate practical use.

In late years most of the State nurseries in the Northeast have begun to keep records of seed origin, and to obtain seed from the best local stands and individual trees. In Pennsylvania and New York particularly, there has been great interest in the best races for Christmas tree planting.

Breeding and Inheritance Studies

Since there has been no pressure for extensive forest planting in the Northeast, forest tree improvement research has been directed along more fundamental lines. This involves controlled breeding to create improved hybrid trees and to determine the mode of inheritance of important forest and use characteristics.

The part-time breeding project with chestnut started in 1909 by Dr. Van Fleet for the Division of Forest Pathology reverted to a maintenance basis after a few years. In the late 1920's the Division of Forest Pathology revitalized this work and has carried it on ever since.

In 1924 the Oxford Paper Company and the New York Botanical Garden started a cooperative project for the breeding of fast-growing hybrid poplars for pulpwood reforestation. In 1936 this project was transferred to the Northeastern Forest Experiment Station of the U. S. Forest Service. The Station has continued the poplar-breeding work. It has also been breeding other genera, including birch, ash, maple, pine, spruce, and a limited amount of work with the oaks. Between 1937 and 1940 the Station also investigated the possibilities of colchicine-induced polyploidy in hybrid poplars.

The Brooklyn Botanical Garden started breeding work for disease-resistant forest-type chestnuts in 1930. This project was transferred to the Connecticut Agricultural Experiment Station in 1947. In 1952 the Connecticut Station started a second project on the improvement of hemlock.

The Maria Moors Cabot Foundation for Botanical Research was established at Harvard University in 1937. It is carrying on genetics studies of coniferous species (particularly species of Pinus), studies of variation patterns in native Populus species, and studies of variation in red oak and red maple. Most of the studies of the Cabot Foundation are of a fundamental nature with emphasis on investigation of natural variation within the species.

Within the last few years the Boyce Thompson Institute for Plant Research, Inc., has undertaken a project on larch breeding, including investigations of vegetative propagation.

The Botany Department of the College of Forestry at Syracuse has been testing native and exotic white pines for resistance to blister rust for at least 10 years.

Apparently the earliest work on vegetative propagation of forest trees for forest planting was started in 1936 by the Northeastern Forest Experiment Station. Intensive work was also carried on by the Cabot Foundation during the early years after its establishment. Propagation from cuttings hasn't turned out to be as easy as we had hoped, but the results obtained in many laboratories and experiment stations in the Northeast indicate that there are still possibilities to be explored. At present research on this problem is continuing at the University of Massachusetts, the Boyce Thompson Institute, at the University of Vermont (with sugar maples), and at one or two other stations. There has also been sporadic work in this region on grafting techniques for conifers.

Irradiation research with forest tree seeds has been carried on at Harvard and has recently been started at the University of Massachusetts.

The Boom In Forest Tree Improvement Activity

As in other regions of the United States, and indeed in the world, the past few years have seen a boom in forest tree improvement activity. It appears to some of us that now "almost everyone wants to climb on the bandwagon." We welcome this situation. And to lend a helping hand to everyone in the Northeast who is seriously interested in climbing on the bandwagon with us, the Northeastern Forest Tree Improvement Conference was organized in August 1953. As pointed out at the first meeting of the Conference, the program for the 1953 meeting was oriented along three major lines:

1. *Improvement objectives from the viewpoint of practice and research*, because it is obvious that we must know in what particular characteristics improvement is required.

2. *Improvement through selection of wild types*, because this will provide improved trees for planting and because it is the main avenue of approach to the improvement of stands that will never be regenerated artificially.

3. *Improvement through breeding and hybridization*, because this seems to offer the greatest ultimate possibilities for attaining improved types.

The 105 pages of the published Proceedings of the First Northeastern Forest Tree Improvement Conference cover the present status of forest tree improvement in this region in considerable detail. Even a casual reading of the formal papers and the discussions from the

floor indicates the present widespread interest in this region.

The awareness of the need for better forest trees, not only in the minds of research and practicing foresters but also in the minds of those directing our highly diverse forest industries, is ample evidence that the time is ripe for rapid progress in forest tree improvement. The bandwagon is filling rapidly. It is our expectation that the Northeastern Forest Tree Improvement Conference will provide the direction and leadership to make it a profitable ride.

ERNST J. SCHREINER[1]
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Forest Genetics Research in the Northern Rocky Mountain Region

Forest genetics research in the northern Rocky Mountain region began in 1911 with the initiation of a ponderosa pine seed origin study. Additional formally organized work was not attempted, however, until 1948, which marked the start of a series of field tests of hybrids produced at the Institute of Forest Genetics, Placerville, California. In 1949 several cooperating organizations undertook a project designed to breed blister-rust resistant and otherwise superior western white pines. It is still by far the largest active project. The Forest Genetics Steering Committee was organized in the spring of 1950. Since then, activities have been expanded to include a small amount of work on hybridization and vegetative propagation techniques.

Past and Current Work

Ponderosa pine seed origin study.—Between 1911 and 1917, the Northern Rocky Mountain Forest and Range Experiment Station[1] planted ponderosa pine seed at the Priest River Experimental Forest from widely distributed localities throughout the range of the species. A detailed examination of the trees in 1935 revealed differences in diameter and height growth, shape of crowns, sensitivity to freezing, number of needles to the fascicle, and thickening of needle hypoderm. The differences suggested that certain traits are inherent and that there are distinct geographic races of ponderosa pine. Information gained from the study also showed the most generally suitable territory in which to collect ponderosa pine seed for planting in northern Idaho.

Blister-rust resistant western white pine project.—Development of rust-resistant western white pine was started in 1949 by cooperating federal agencies. To date, 72 apparently rust-resistant selections have been made in 12 areas of extremely heavy blister-rust infection. Grafted clones of these are being or already have been tested for rust resistance, and 40 selections have already yielded 240 intraspecific and 20 interspecific controlled crosses, also scheduled for rust-resistance tests.

Investigations of self-fertility and self-compatibility in western white pine.—A companion project in the production and testing of F_1 progenies of rust-resistant western white pines is the production and observation of self-pollinated progenies. To date 28 selfed progenies are in production and under observation. Early results indicate that the white pine tested comprise a moderately self-compatible sample, and that pronounced reduction in height growth of seedlings accompanies selfing. Implications in future seed orchard work may be of importance.

Vegetative propagation techniques.—The Division of Blister Rust Control, Northern Region of the Forest Service, has developed several satisfactory techniques for grafting western white pines. Small-scale trials designed to stimulate early flowering in scions taken from seedlings are being conducted, but results, of course, will not be known for several years. Following work commenced by Blister Rust Control in 1949, the Montana State University, School of Forestry, is experimenting with rooting of cuttings. To date, some success has been attained in rooting cuttings taken from 30-year-old and younger trees.

Hybridization and field testing of hybrids.—Several pine hybrids developed by the California Forest and Range Experiment Station are being field tested by the Intermountain Forest and Range Experiment Station. These include *Pinus contorta* × *P. banksiana*, *P. ponderosa* × *P. ponderosa* v. *scopulorum*, *P. ponderosa* × *P. engelmannii*, crosses between eastern and western white pines from several sources, and a cross between western white and Himalayan pine. The white pine hybrids, now 3 years old, appear to be more vigorous than seedlings of the parent species.

All of the above-named hybrids being field tested were produced on seed parents growing outside of this region. Since it is felt that success may be better if the hybrids are produced on local trees, the above-named hybrids are being remade using seed parents of local origin. Two other hybrids are being produced along with those currently being field tested, namely, *P. ponderosa* × *P. ponderosa* v. *arizonica* and *P. ponderosa* × *P. montezumae*.

Development of a strain of ponderosa pine suitable for planting as a substitute for western white pine.—In 1953 a small project was begun to test the suitability of progenies from selected ponderosa pines, growing well within the white pine type, for planting on white pine sites. A number of ponderosa pine trees were selected in four areas and seven were hand-pollinated to insure cross-pollination.

Forest Genetics Steering Committee.—In July 1950 representatives from a group of institutions

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[1] Now consolidated with the Intermountain Forest and Range Experiment Station, Forest Service, U. S. Dept. Agric., Ogden, Utah.

within the northern Rocky Mountains, which are active or interested in forest genetics research, organized the Forest Genetics Steering Committee to stimulate interest in forest genetics and to coordinate research within the region where the member institutions operate. The committee includes representatives from the following institutions:

Montana State University; University of Idaho; Washington State College; U.S. Forest Service Intermountain Forest and Range Experiment Station, Northern Region, Division of Timber Management, and Northern Region, Blister Rust Control.

Search for superior trees.—A guide for selecting superior trees in the northern Rocky Mountains has been prepared by the Forest Genetics Steering Committee. Some progress has been made in selecting superior western white and ponderosa pines and it is hoped selection work may be extended to other species and other desirable types of trees.

The Future

Potentialities for forest tree improvement in the region are enormous. Opportunities for research are practically unlimited. Important questions of the moment are: (1) Which present and proposed projects and lines of work should be given priority? (2) What are the possibilities for getting the work done?

To attempt to set up a rigid schedule of priorities for research in this region would be difficult at present. It would need, among other things, to be based upon comprehensive economic studies. We can only make tentative recommendations as to which specific projects or types of work should be done first and which may be postponed temporarily. Finally, we may look into the possibilities for expanding our research effort.

Recommendations.—1. Continue the western white pine breeding project at least to the point where heritability of rust resistance in the selected trees is determined. If successful, expand the selection work to include trees that appear to be superior in growth rate and timber quality. If attempts to establish rust resistance fail, concentrate more effort toward hybridization of western white pine with resistant exotics.

2. Expand efforts to breed ponderosa pines superior in growth rate and timber quality. This species has high commercial importance in western Montana and, with improved strains and changing market conditions, will undoubtedly become more important in eastern Montana.

3. Launch a program designed to breed superior Douglas-fir Christmas trees. The Christmas tree industry in western Montana has expanded rapidly in recent years. Changing market conditions, dangers of loss in quality through rapid cutting, and losses from diseases also give this project high priority.

4. Continue attempts to develop a strain of ponderosa pine suitable for planting as a substitute for western white pine on white pine lands where rust control is impracticable.

5. Initiate or expand breeding programs in other species of lesser commercial importance as facilities permit. The lodgepole pine-jack pine hybrid work already started should, of course, be carried on to completion. Improvement of specific traits in other species such as resistance to dwarf mistletoe, freedom from shake, and early rapid growth in western larch can well be considered in the future.

6. Register superior trees and stands of trees of any commercially important species as they are found. Records of such trees or stands may be very valuable for future breeding programs.

7. In general research efforts in this region should be concentrated largely on improvement through selection and development of superior strains and such hybridization as must be done locally. Present facilities in the region do not permit extensive hybridization work, efforts to develop methods of inducing polyploidy or aneuploidy, and other highly specialized technical studies.

8. Future provenance studies initiated in conjunction with specific breeding projects should be carried out on a more intensive basis. Distinctions between habitats and ecotypes need to be refined. Future tests should give greater attention to specific factors of environment and less attention to simple geographic location.

Facilities.—Existing facilities within the region permit forest genetics research on only a modest scale. The present work now being carried on by the federal government and certain schools could well be strengthened. Other educational institutions, agencies, and private forest industry should be encouraged to initiate or cooperate in genetics studies. Graduate students should be directed to small studies which may be conducted in conjunction with existing projects, such as identifying resistance factors in white pine blister-rust resistant selections. Finally, regardless of the amount of work done here, we in the northern Rocky Mountain region should encourage research work in other regions and use its results to the fullest extent possible.

A. E. SQUILLACE and
R. T. BINGHAM
For the Forest Genetics Steering Committee of the Northern Rocky Mountain Region

Forest Tree Improvement Activities in the Pacific Northwest

Programs of forest tree improvement in the Pacific Northwest are of quite recent, or more accurately, contemporary origin. Nevertheless, whatever the nature of the programs which eventually develop in this region, they are likely to owe much to work started more than 40 years ago. In 1912, the Wind River Arboretum and a region-wide provenance test of Douglas-fir were established (*3, 5*). In 1926 a provenance test of ponderosa pine was established (*4*). Meanwhile, the 180-acre arboretum at Oregon State College, now known as the Peavy Arboretum, had been started. These arboreta, and the 11 planta-

tions which comprise the two provenance tests have been maintained and continuously studied, with the result that present workers in tree improvement have a firm, even though not very extensive, background of knowledge of the behavior of numerous native and exotic tree species in the region.

Current and proposed activities in the Pacific Northwest may be grouped under the headings of provenance tests, selection of good phenotypes as individuals and in stands, vegetative propagation, and controlled pollination studies.

Provenance tests are in the early planning stage, with Dale N. Bever, of the Oregon State Board of Forestry, taking the lead in organizing a cooperative provenance test of Douglas-fir proposed for Oregon, Washington, and British Columbia. To judge from the published experience in the South-wide provenance tests of the principal pine species, it is estimated that the Douglas-fir test may not reach the nursery stage for several years.

Selection of good phenotypes is an increasingly popular activity in the Pacific Northwest. Formal standards for excellence remain to be drawn up in rigorous detail, but there is a certain area of agreement on what constitutes a good Douglas-fir. The other major species in this region have, so far, received less attention, but western hemlock is certain to assume a prominent place in this work. As a feature of the search for good phenotypes, the development of a region-wide register of trees is being planned by Leo A. Isaac of the Pacific Northwest Forest and Range Experiment Station. In addition to the search for good individual phenotypes to be used in intensive improvement work, the U. S. Forest Service is initiating a more extensive program of locating good stands throughout the National Forests of the region to which cone-collecting efforts will be particularly directed (*7*). Finally, the vegetative propagation of good phenotypes is already under way. Among the agencies engaged in this phase of the program are Weyerhaeuser Timber Co., St. Paul and Tacoma Lumber Co., Bloedel Timberlands Development, Inc., Perpetual Forests, Inc., and the College of Forestry, University of Washington.

Another phase of selection work is being prosecuted by the pathologists. In Oregon, mistletoe-free ponderosa pines have been found as rare occurrences in reproduction thickets heavily infected with mistletoe (*8*), and it is planned to propagate some of these by grafting. In British Columbia, W. A. Porter of the Dominion Laboratory of Forest Biology, is propagating and progeny-testing by controlled pollinations blister-rust-free white pines found in areas of heavy infection on Vancouver Island. Similar work is scheduled to start in western Washington in 1954, in cooperation with the work already under way in Canada and Idaho (*2*).

Controlled pollination studies in the Pacific Northwest are starting. The lead has been taken in British Columbia, where self-compatibility and inbreeding behavior in Douglas-fir has been studied (*1, 6*). In Washington, experiments in controlled pollination have been initiated by the Weyerhaeuser Timber Co., and crosses designed to test inheritance of resistance of Douglas-fir to *Rhabdocline pseudotsugae* have been made by R. K. Campbell at the University of Washington. The U. S. Forest Service and several private timberland owners are field testing pine species hybrids made at the Institute of Forest Genetics.

So far, no regional organization concerned with forest tree improvement has developed in the Pacific Northwest. However, it seems likely that in this region, where foresters have a long and successful tradition of concerted attack on common problems, such an organization may soon take shape.

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Reviews

Industry in the Pacific Northwest and the Location Theory

By Edwin J. Cohn, Jr. 214 pp. Illus. Columbia University Press, New York. 1954. $3.50.

The author explains the theory of location of industry based on markets, raw resources, transportation, climate, labor force, and other influences. Using the Pacific Northwest as his example he shows how physical features of the land and climate of the area exert pressure; how growth of population attracts industrial development; and how character of industry reflects available resources and history of settlement.

In describing the nature and distribution of Northwest industry, Cohn places development in five categories: (1) resources—oriented; (2) secondary processing; (3) satellites of raw material—processing industries; (4) consumer—oriented; and (5) industries developed in the Northwest by chance. He shows where these industrial developments have taken place and why; that availability of electric power has not in itself resulted in decentralization, although the national tendency of industry to move away from the center of the city is apparent in the Northwest also, retaining advantages of labor supply, market, transportation, and services while securing savings in rent.

In discussing forest products industries, the author traces the historical development in three stages: (1) minimum manufacture exemplified by the ox team and the waterfront mill; (2) the logging railroad period; and (3) mobile logging by truck, logging tractor, and arch. He shows the importance of mobility and its effect on large and small plants. Cohn pays tribute to increasing utilization with special emphasis on wood pulping. He shows the trend of production for pulp mills, the chipping of mill wastes for pulp, and points out that sulphite pulping is now developing in British Columbia because of limited material suitable for sulphite, although kraft or sulphate milling still has the possibility of expansion.

He discusses the importance of water in pulping, the large investments necessary, the importance of horizontal integration, and the place of the hydraulic barker in increasing utilization.

The character of the lumber industry depending on location and type of forests and possibilities for production of byproducts are discussed.

Cohn points out that a major portion of the product is shipped out of the region in the primary manufacturing form, providing a minimum of employment, due to transportation costs and market location. A case is built for the manufacture of rayon in the Northwest for the same reasons, coupled with the growing California production of clothing and tires.

The development of auxiliary plants furnishing special clothing, logging and milling equipment, chemicals and other needs peculiar to the region's industry is covered. The food-processing industry, second only to forest products in the Northwest, is described.

Cohn's development of the location theory as exemplified by industrial growth in the Northwest is a scholarly and logical work. Inevitably, however, the writer has come to the conclusion that the book "sells" the West Coast, and especially the Northwest, "short." The author fails to grasp the growth potential of our forest lands; doesn't concern himself with British Columbia and Alaska timber, minerals, water power, and soil, nor does he appear aware of the great market growing in California. The slow and painful evolution Cohn describes hardly seems in keeping with the population increase experienced in the far West from 1929 to 1951 (from 11.7 million to 20.2 million), or with the present rate of growth (far above most regions).

GEORGE H. SCHROEDER
Crown Zellerbach Corporation

The Conservation Yearbook, 1954

Edited by Erle Kauffman. 320 pp. The Conservation Yearbook, 1740 K Street N. W., Washington 6, D. C. 1954. $6.

Welcome to the third edition of this annual directory of organizations concerned with the management of renewable natural resources. What started out as a useful guide to key individuals and agencies engaged in conservation has developed into an indispensable reference tool for the conservation worker.

More comprehensive than the two previous volumes, the 1954 *Yearbook* is truly a remarkable compendium of information. Packed in some 300 pages are the current facts and figures on just about any and every facet of conservation one could imagine.

This reviewer considered it a triumph in editing when Erle Kauffman first compiled directories of 500 conservation organizations —national, regional, state, and local—together with the names and addresses of their officers. But now the editor has outdone himself with a roster of some 200 key forestry officials in industry.

If any pertinent or useful information has been omitted, truly this reviewer does not know what it could be. It is all here—data on forests, soil, water, parks, wildlife, and range; the executives and technicians in charge; the location and acreage involved—in short, the where, the who, and the what of conservation.

About the highest praise I can give this excellent book is to say it contains just about everything, and what's more you can find it.

HENRY CLEPPER

A Method of Estimating Timber Volumes from Aerial Photographs

By Miles J. Ferree. 50 pp. Illus. State University of New York, College of Forestry, Syracuse 10, N. Y. 1953. $1.

In a forest survey there are several methods for obtaining the necessary volume data and among these are several methods for the use of vertical aerial photographs. The method set forth in this publication is very complete and shows that a lot of study has gone into it. Mr. Ferree has been associated with aerial surveys as they pertain to forestry since 1940 and is familiar with the use of aerial photographs.

This report does not cover all details of a forest survey, but special emphasis is placed on the gross timber volume estimating phase; it assumes that foresters using this method are familiar with conventional ways of determining all factors, mortality figures, growth rates, and quality values, as presented in the stands being studied. Considerable field work is necessary before this particular method can be used and must be continued during the actual aerial survey as applied in the office.

For gross volume determination the author has developed a crown-d.b.h. relationship. The crown diameters are measured on the photographs and converted to tree volumes by using site-class, crown diameter volume tables.

Methods of collected field data are clearly set forth with suggested forms for recording these data. In order to convert the field data to gross timber volume, then to desired volumes such as net volumes, merchantable volumes, etc., volume tables must be prepared, based on crown diameter. Considerable work must be done in the field obtaining data on cull, mortality and growth. Growth must be taken into consideration for the age of the pictures used. Probably photography up to ten years ago could be used with this method.

Throughout this publication all computations pertaining to volume are in cubic feet and board feet, but the cord unit could be used if desired.

Those who have used aerial photos in forestry know that measurements should be confined to the center portion of the picture. This is particularly true with this method. Differences in elevation of over two hundred feet should also be taken into consideration and adjustments in scale should be made in all measurements.

This method of using mean crown diameter is not too difficult and can be applied to all forest types and volume-per-acre conditions provided the individual stands studied contain crowns of fairly uniform size. Additional field work will take care of deviations in the crown size for mixed stands and small size timber where the individual crowns are too small for measurement. The appendix contains numerous definitions of terms used in the text, plus 33 tables on volume for crown diameters for various timber sizes, sites, and types, mainly for the northeastern area of the United States.

Any forester contemplating a forest survey from aerial photographs should read this publication.

MYLES STANDISH

Applied Forest Management

By Paul E. Bruns. 383 pp. Illus. Paul E. Bruns, Missoula, Mont. 1954. $5.

Prof. Bruns has written an American forest management text free of musty theory and replete with valuable information necessary in the carrying out of the field forester's daily assignments.

He first delineates the scope of the subject by showing the effect of time and place, the requirements and objectives of management, and the place of technical skills and organizational techniques. Putting first things first, he outlines the requirements of extensive forestry in which the bare bones of protection, communication, marketing and financing are examined and placed in their proper place one to the other. A chapter has to do with the economics of logging and forestry, it explains the procedure of stumpage appraisal and describes the marginal tree, the development of tree grades, and illustrates the values involved. The forest inventories chapter describes the kinds of surveys, their uses and limitations, clearly explains how the forester can get the most out of air photos, and breaks down sampling theory into readily understood words. The application of the statistical method in cruising, the field selection of samples, and the final forest inventory compilations are explained.

Management of young growth timber is discussed in terms of regeneration, intermediate cuttings, forest soils, and growth determinations. The author considers regulation as the planned control of volume harvested to achieve a continuous yield based on a rotation and cutting cycle consistent with the objectives of management. The area concept in regulation as well as the various formula methods is described to determine a cutting budget.

The chapter on the management plan deals with small as well as large forests and leads to business records systematic tabulations, working plans, maps, subdivision of land, and field and office forms.

The interrelationship of grazing, wildlife, recreation and water with wood production is part of forest land use coordination. No doubt is left in the mind of the reader but that all have their place in the forester's manipulation of the resource for the objectives of management.

A concluding chapter deals with wood supply-demand relationships, with the American as opposed to the European version of intensive forest management, and with employment possibilities. It ends with a careful summation of wood supply-demand in the United States.

Any practicing forester in the United States should profit by having this work available for day-by-day use.

GEO. H. SCHROEDER

The Pacific Northwest: An Over-All Appreciation.

By Otis W. Freeman and Howard H. Martin. 2nd edition. 540 pp. Illus. John Wiley & Sons, Inc., New York 16, N. Y. 1954. $8.50.

The need for an all embracing economic and physical history of the Pacific Coast Region has been well met by this volume.

Readers of the JOURNAL OF FORESTRY will have a professional interest in the chapters devoted to "Forests of the Pacific Northwest" and "Forest Utilization," by Stephen Wyckoff and Jim Stevens. Wyckoff has written an admirable chapter for both the layman and the professional, but one regrets that he has so few pages in which to state his forest facts. He has managed, in one short paragraph, simply and beautifully to describe "the nature of the forest." There is one slight but significant omission—nowhere in the book is there a definition of a "board foot." It may seem ridiculous, but many who use the term "board foot" as a unit of measurement do not know what it is.

Jim Stevens reveals the professional touch, and his chapter carries the reader from the stump through the logging and utilization operations of the lumber industry. One can regret that the methods of the 1920's and the 1950's are not compared, for one jumps directly into the most modern practices of utilization in plant and mill.

The enormous strides made in utilization of wood fibre during the past twenty years are passed over, although significant mention is made of salvage logging, a most important contribution of the past decade to full utilization of the forest crop. We are taken on a tour of sawmills, plywood plants, sulphite and sulphate mills, through hardboard factories to the problems of forest management and prevention and control of forest fires. Mention, however brief, is made of cooperation in research and progressive forest utilization, while the final paragraph points up the significant fact that "a probable 40 percent of the region's timber harvest is from young growth on cut-overs and burns."

Certainly progress and economics are interrelated.

Each chapter of this book is complete within itself. So one reads of "Soils and their Conservation" as well as a complete chapter, by Dr. Church, on "Climates of the Pacific Northwest." The forester will find many significant clues to growth rates and species in the table devoted to rainfall, snow depths, and length of growing season.

The diverse wealth of the region is well projected in the chapters devoted to grass land management, water use, fisheries, and minerals. The fisheries chapter reveals that sustained yield is no less a problem in that resource than in lumbering. In both pursuits, the problem appears to be one of control of yield and protection, although the forest protectionist could wish that his "yield" were as fireproof as the salmon and halibut yields of the ocean.

Other chapters devoted to agriculture, game, floriculture, waterways and water power, transportation, manufacturing, and a most interesting account of "Indian Life of the Pacific Northwest," by Dr. Erna Gunther, all combine to give an understandable and comprehensive picture of the Pacific Northwest, its history, its resources, and its development.

C. S. COWAN

Forest Diseases and Insects of Georgia's Trees

By L. W. R. Jackson, G. E. Thompson, and H. O. Lund. 40 pp. Illus. Georgia Forestry Commission, Atlanta. 1954. Free.

Extensively illustrated with detailed photographs and drawings, this booklet was designed to provide helpful information to the forester and forest land owner.

The purpose of the book is to describe the most common diseases and insects that attack trees in various stages of growth—from seedlings in nurseries to mature trees in both planted and natural stands. Recommendations are given for the control of these diseases and insects. References also are made to diseases and insect pests of shade and ornamental trees.

Copies may be obtained from the Georgia Forestry Commission, State Capitol, Atlanta, or from the Georgia Extension Service, Athens.

Publications of Interest

Aspen Forests is a free publication of the American Boxboard Company of Filler City, Mich. It is prepared for use by private timberland owners in the northern half of the Lower Peninsula of that state, but will doubtless prove of interest to foresters concerned with management or utilization of this species.

* * *

Economics of Forest Management, Forestry Branch Bulletin 112, Department of Northern Affairs and National Resources, Canada ($2). This is a specific and detailed study of the economic aspects of sustained yield management for pulpwood on a 1,000 square mile forest area in eastern Quebec. The study was made in cooperation with the Anglo-Canadian Pulp and Paper Mills Ltd. It "is an attempt to develop a method whereby the forest operator may test for himself the economic feasibility of sustained yield forest management on a particular area." Although actual company costs were studied, cost figures are presented only as illustrative figures used to indicate the relative value of each cost factor compared to the total cost, not as actual cost incurred by the company.

* * *

Foreman Training, training guide No. 1, American Pulpwood Association, 220 East 42nd St., New York 17, is a good practical guide for training woods foreman in that industry. Much of it is applicable to any woods work or to general foreman responsibilities. Price or availability unknown.

Current Literature

Compiled by MARTHA MEELIG, *Librarian, State University of New York College of Forestry*

Range Management Section Compiled by FRANCES FLICK, *Library, U. S. Department of Agriculture*

General

Adirondack Country. By W. C. White. 315 pp. Duell-Little, Brown, New York. 1954. $4.50.

Forestry in Minnesota, Past, Present and Future. 100 pp. Illus. School of Forestry, Univ. of Minnesota, St. Paul. 1954.

Farm Forestry

Farm Woodland Management in the Southern Appalachians; An 8-Year Summary. By R. A. Campbell. 9 pp. Illus. Southeastern Forest Expt. Sta., Asheville, N. C. 1954. Sta. Paper No. 41.

Forest Influences

Impact of the Proposed Libby Dam Upon the Forest Economy of Lincoln County, Montana. By C. S. Webb, W. W. Gano, Paul Logan and S. B. Hutchison. 305 pp. Illus., maps. U. S. Forest Serv. Region 1, Missoula. 1953. Mimeog.

Forest Management

Determination of the Volume of Trees. By Julian Perkal. 14 pp. Wroclawskie Towarzystwo Naukowe, Wroclaw, Poland. 1953. Communication No. 7.

Estimating Volume from Stump Measurements. By K. L. Quigley. 5 pp. Central States Forest Expt. Sta., Columbus 15, Ohio. 1954. Technical Paper No. 142. Mimeog.

Volume Charts Based on Absolute Form Class. Adapted by S. E. Fogelberg from Tree Taper Based on Hoejer's Formula, 2d ed. Ed. by E. J. Russell. 11 pp. Charts. Louisiana Tech Forestry Club, Box 50 Tech Sta., Ruston, La. 1953. $3.00.

Forest Products

Marketing Woodlot Products in the State of Washington. By George Stenzel. 56 pp. Illus. Institute of Forest Products, Univ. of Washington, Seattle 5. 1954. Bul. No. 15.

Forest Resources

Forest Statistics for North Central and North Georgia 1953. By J. F. McCormack. 31 pp. Southeastern Forest Expt. Sta., Asheville, N. C. 1954. Forest Survey Release No. 42. Mimeog.

The Forests and Economy of Lewis County, New York. By George Armstrong. 49 pp. Illus. State Univ. of New York College of Forestry, Syracuse 10. 1954. Bul. No. 33. 75 cents.

1953 Pulpwood Production in the South. By J. W. Cruikshank. 32 pp. Maps, charts. Southeastern Forest Expt. Sta., Asheville, N. C. 1954. Forest Survey Release No. 43. Mimeog.

Timber Resources and the Economy of the Saranac Lake-Lake Placid Area. By C. C. Larson. 42 pp. Illus. State Univ. of New York College of Forestry, Syracuse 10. 1954. Bul. No. 32. 75 cents.

Protection

Controlling Pine Beetles in South Carolina Woodlands. By W. J. Barker and W. C. Nettles. Illus. folder. Clemson Agric. College, Clemson, S. C. 1954. Cir. No. 239.

Powder-Post Beetles in Building; What To Do About Them. 8 pp. Illus. U. S. Dept. of Agric., Washington 25, D. C. 1954. Leaflet No. 358. 5 cents (Govt. Print. Off.)

Termites and Other Wood-Infesting Insects. By L. A. Hetrick. 22 pp. Illus. Florida Agric. Ext. Serv., Gainesville, Fla. 1954. Bul. No. 157.

Range Management

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The Cowboy's Own Brand Book. By D. Emrich. 69 pp. Illus. Thos. Y. Crowell Co., New York. 1954. $1.50.

Forage Production in Oak Woodland as Influenced by Removal of Tree Cover. By P. T. Koshi and others. 4 pp. Illus. Tex. Agric. Expt. Sta., College Station. Progress Rpt. No. 1661. March 26, 1954. Mimeog.

Introduction of Forage Plants for Seeding Western Range. By A. C. Hull and H. Hyland. 5 pp. U. S. Forest Serv., Off. of Range Management Research, Washington 25, D. C. 1954. Mimeog.

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Subalpine Vegetation of the Wasatch Plateau, Utah. By L. Ellison. Ecological Monographs, Durham, N.C. Vol. 24, pp. 89-184. April, 1954.

Silviculture

Cold Weather and Glaze Damage to Forest Plantations in Southern Illinois By W. R. Boggess and F. W. McMillan. 23 pp. Illus. Univ. of Illinois Agric. Expt. Sta., Urbana, Ill. 1954. Bul. No. 574.

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Recent Development in Planting and Direct Seeding in the Southern Pine Region. Proceedings Third Annual Forestry Symposium School of Forestry Louisiana State University, Baton Rouge . . . April 8-9, 1954. 104 pp.

Reproducing Pine Stands on the Eastern Shore of Maryland Using a Seed-Tree Cutting and Preparing Seedbeds with Machinery and Summer Fires. By S. Little and J. J. Mohr. 11 pp. Northeastern Forest Expt. Sta., Upper Darby, Pa. 1954. Sta. Paper No. 67.

Use of Plant Indicators as an Index to Site Quality. By Marinus Westveld. 5 pp. Northeastern Forest Expt. Sta., Upper Darby, Pa. 1954. Sta. Paper No. 69.

Soils

Forest Soils of Japan; Report 4. 116 pp. Illus., maps. Govt. Forest Expt. Sta., Meguro, Japan. 1954.

Methods of Soil Moisture Determination Under Field Conditions. By D. F. Olson, Jr., and M. D. Hoover. 28 pp. Illus. Southeastern Forest Expt. Sta., Asheville, N. C. 1954. Sta. Paper No. 38.

Soil Sampling for Pore Space and Percolation. By M. D. Hoover, D. F. Olson, Jr., and L. J. Metz. 28 pp. Illus. Southeastern Forest Expt. Sta., Asheville, N. C. 1954. Sta. Paper No. 42.

Wildlife Management

Animal Control in Field, Farm, and Forest. By W. R. Eadie. 257 pp. Macmillan, N. Y. 1954. $3.75.

Wood Technology and Utilization

Dielectric Heating as Applied to the Woodworking Industries. By R. W. Peterson. 40 pp. Illus. Forest Products Laboratories, Ottawa, Canada. 1954. Bul. No. 110.

Getting Better Service from Fence Posts. By L. S. Hamilton. 4 pp. State Univ. of New York College of Agriculture Ext. Serv., Ithaca, N. Y. 1953. Dept. Conserv. Mimeo Leaflet No. 8.

The Machining of Beech. By S. H. McIntire. 6 pp. Northeastern Forest Expt. Sta., Upper Darby, Pa. 1954. Beech Util. Ser. No. 9. Mimeog.

Racking Tests on Quarter-Scale Diagonally Sheathed Wall Panels. By J. R. Stillinger. 27 pp. Illus. Oregon Forest Products Laboratory, Corvallis. 1954. Report No. T-1. Mimeog.

Seasoning and Machining Degrade in Young-Growth Douglas-Fir Dimension Lumber. By B. G. Anderson, A. C. Knauss and R. G. Frashour. 29 pp. Illus., charts. Oregon Forest Products Laboratory, Corvallis. 1954. Report No. D-1. Mimeog.

Vapor Drying of Western Woods. By R. D. Graham. 11 pp. Illus. Oregon Forest Products Laboratory, Corvallis. 1954. Report No. D-2. Mimeog.

Wood Anatomy of the Betulaceae Indigenous to the United States. By E. W. Stark. 30 pp. Illus. Purdue Univ. Agric. Expt. Sta., Lafayette, Ind. 1954. Sta. Bul. No. 602.

Suggestions for Contributors

The following suggestions for authors will help expedite the review and printing of articles submitted to the JOURNAL OF FORESTRY.

A paper submitted for publication should be the very best the writer is capable of producing with all tables, quotations, names, and formulae verified before submission. The careful author will have his final typescript reviewed by a colleague in order to eliminate errors. The associate editors, who review all papers for technical quality, give their services gratuitously and it is an imposition on them to submit carelessly prepared material.

Papers should be submitted directly to the editor, who will then place them in the hands of the proper member or members of the editorial board.

The Typescript

Papers should be typewritten, with ample margins, on one side only of white bond paper, size 8½ by 11 inches, or 8 by 10½ inches. Papers typewritten on "onionskin" or transparent paper and carbon copies are not acceptable.

All copy, including quotations, footnotes, tables, literature references, and captions for illustrations and figures, should be double-spaced.

The author's name and address should appear in the upper left-hand corner of the first page.

Pages should be numbered consecutively, preferably in the upper right-hand corner of each sheet.

Only words intended to be set in italics should be underlined. (Some typists underline titles, center-heads, sideheads, and other words. These typographical flourishes are not only useless; they are a nuisance to the editor.)

In text material such as equations and formulae that exceed (approximately) 2⅛ inches when set in type cannot be carried in a single line in a JOURNAL column. (Roughly speaking, any such material that exceeds thirty three spaces on the typewriter.) Such material should be presented in tabular form rather than in the text.

Tables

Each table should be typewritten on a separate sheet and should be given a title. Tables should be numbered consecutively, and even if only one table is submitted it should be designated Table 1.

Footnotes used in tables should be designated by numbers, never by asterisks or other typographical symbols.

Illustrations and Figures

An illustration—whether a photograph, a line drawing, a map, or a graph—is designated as a figure; abbreviated Fig. A caption should be submitted for each illustration, but the caption should not be incorporated in the figure. Captions are set in type by the printer, hence should be typewritten on a separate sheet.

All figures should be numbered consecutively. Even if only one is submitted it should be designated Fig. 1.

On the margin or back of each illustration should be written lightly in soft pencil the number of the figure, the name of the author, and an abbreviated title of the article.

Photographs should be sharp and clear, printed on glossy paper. They should never be smaller than 4 by 5 inches; sizes 5 by 7 inches and 8 by 10 inches are preferable. Photographs should never be rolled or bent. They should never be fastened with paper clips which often make identations that show up in reproduction. A piece of paper folded several times and used as a guard will prevent damage by a paper clip.

Drawings, maps, charts, and graphs are reproduced as line engravings. They should be at least twice as large as they are to appear when reproduced. They should be drawn in India ink on heavy white paper, Bristol board, or tracing cloth.

Footnotes

A footnote should be designated by separating it from the text by running a line about one inch inward from the left margin of the type. To indicate a footnote: after the word that refers to the note place a superior figure which must be identical with the figure that precedes the note.

In copy intended for the JOURNAL, footnotes should never be indicated by asterisks. They should be numbered consecutively throughout the paper.

When used in tables, footnotes should be numbered consecutively, beginning with 1, in each table. Such footnotes should be typewritten as part of the table to which they apply.

Literature Cited

In JOURNAL practice, literature citations are listed in alphabetical order by authors' names, beginning with number 1. The citations are then referred to in the text by the appropriate numbers.

A citation of an article in a periodical publication is as follows: author's name and initials, year of publication, title of article, name of the periodical, volume number, and pages.

A citation of a book is as follows: author's name, year of publication, title, publisher, and place of publication. If it is desirable to refer to specific page numbers, they can be designated at the end of the citation.

Standard abbreviations are used. If there is more than one author, only the name of the first should be transposed. *Examples:*

1. Buell, J. H. 1954. Problems facing forest management in the Central Rocky Mountains. Jour. Forestry 52: 163-165.
2. Davis, K. P. 1954. American forest management. McGraw-Hill Book Co., New York. pp. 251-253.
3. Day, R. K., and D. DenUyl. 1932. The natural regeneration of farmwoods. Purdue Univ. Agric. Expt. Sta. Bul. 368. p. 16.

Nomenclature and Terminology

When a botanical species, or for that matter any biological species, is first mentioned in a paper its common name may be immediately followed by its italicized scientific name in parenthesis, but this latter name need not thereafter be repeated.

As the authority for the exact spelling of tree names the JOURNAL follows *Check List of Native and Naturalized Trees of the United States (including Alaska)*, Agriculture Handbook 41, U.S. Government Printing Office, Washing 25, D. C. 1953.

For the spelling of other plant names contributors should follow *Standardized Plant Names*, 2nd edition, J. Horace McFarland Company, Harrisburg, Pa. 1942.

Contributors in doubt as to the exact meaning of technical terms used in forestry and allied fields are referred to *Forestry Terminology*, 2nd edition, Society of American Foresters, Washington 6, D. C. 1950.

There are many style manuals available for the guidance of writers. One of the best, because it is one of the most comprehensive, is the *Style Manual* of the U.S. Government Printing Office, Washington 25, D. C. 1953.

Webster's *New International Dictionary* is the accepted authority for the general spelling of words.

Society Affairs

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Asheville, N. C.

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Kimberly-Clark Corporation
Neenah, Wis.

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U. S. Forest Service
729 N.E. Oregon Street
Portland 8, Ore.

Ruthford H. Westveld
Department of Forestry
University of Missouri
Columbia, Mo.

Annual Meeting

Society of American Foresters

Milwaukee, Wis., October 24-27, 1954

Theme: "Our Changing Forests"

Schedule of Events

Members, their ladies, and guests who plan to attend the meeting are urgently requested to arrive in Milwaukee on Sunday, October 24, or not later than the morning of Monday, October 25. The opening general session starts on Monday morning.

As will be seen from the following schedule of events, numerous meetings and sessions have been arranged to provide attractions for a diversity of interests.

Sunday, October 24

S.A.F. Council, morning and afternoon meeting.

Journal of Forestry Editorial Board, evening conference.

Committee on Accrediting, evening conference.

Joint meeting of Council and Section delegates, evening.

Council of State Forestry Association Executives, afternoon and evening.

Association of Consulting Foresters, evening.

Monday, October 25

General meeting, morning.

Society Affairs session, afternoon.

Division of Education, evening.

Division of Public Relations, evening.

Division of Watershed Management, evening.

Tuesday, October 26

Division of Forest Products, morning.

Division of Forest Recreation, morning.

Division of Silviculture, morning and afternoon.

Division of Private Forestry, afternoon.

Division of Forest-Wildlife Management, afternoon.

Social evening and college alumni get-togethers, evening.

Wednesday, October 27

Division of Economics and Policy and Division of Education, joint meeting, morning.

Division of Forest Management, morning and afternoon.

Division of Range Management, afternoon.

S.A.F. Social Hour and Dinner, evening.

General Meeting

Monday, October 25

Jay H. Price, Chairman

Morning Session

Theme: "Our Changing Forests."

1. Introduction by the Chairman.

2. "The Forests of the Central and Lake States Region." M. B. Dickerman, Lake States Forest Experiment Station, St. Paul, Minn.

3. "Problems and Potentials of the Fiber Industry."

"The Northern Forests." D. Clark Everest, Marathon Corporation, Rothschild, Wis.

"A Look Across the Border." J. F. Sharpe, Department of Lands and Forests, Toronto, Ont., Canada.

4. "Utilization of Central Hardwoods." Burton F. Swain, National Veneer and Lumber Company, Seymour, Ind.

5. "Management of Our Changing Forests."

"The Northern Forests." J. B. Millar, Kimberly-Clark Corporation, Neenah, Wis.

"The Central Hardwoods." R. H. Westveld, Department of Forestry, University of Missouri, Columbia, Mo.

Society Affairs

Monday, October 25
E. L. Demmon, President
DeWitt Nelson, Vice President

Afternoon Session

1. Report of the President, E. L. Demmon.
2. Report of the Executive Secretary, Henry Clepper.
3. Report of the Editor, Arthur B. Meyer.
4. "The Society's Forestry Research Project." Frank H. Kaufert, Director.
5. Committee Reports.

Open forum discussion.

Division of Education

Monday, October 25
Kenneth P. Davis, Chairman
Archie E. Patterson, Vice Chairman
J. Whitney Floyd, Secretary

Evening Session

1. "The Place of Forest Fire Control in Forestry School Curriculums." R. Keith Arnold, School of Forestry, University of California, Berkeley, Calif.

Discussion.

2. "They Received Forestry Honors and Awards." J. S. Illick, College of Forestry, State University of New York, Syracuse, N. Y.
3. Symposium: "Master's Degrees in Forestry Schools." Moderator: Kenneth P. Davis, School of Natural Resources, University of Michigan, Ann Arbor, Mich.

"Status, Trends, and Perspective in Master Degree Programs." Myron Krueger, School of Forestry, University of California, Berkeley, Calif.

"Building a Master's Degree Program on a Liberal Arts Foundation." Clarence F. Korstian, School of Forestry, Duke University, Durham, N. C.

"Building a Master's Program on an Undergraduate Degree in Forestry." Ernest O. Wohletz, College of Forestry, University of Idaho, Moscow, Idaho.

"Employer Viewpoints":

(1) Private Industry. Bernard L. Orell, Weyerhaeuser Sales Company, St. Paul, Minn.

(2) Public. H. Dean Cochran, U. S. Forest Service, Milwaukee, Wis.

General Discussion by Panel.

Open Discussion by members.

Division of Public Relations

Monday, October 25
Ralph G. Unger, Chairman
Albert K. Wiesendanger, Vice Chairman
C. W. Mattison, Secretary

Evening Session

1. "Trees and People." Melvin N. Taylor, Trees for Tomorrow, Inc., Merrill, Wis.

Discussion.

2. "Forestry Extension in Indiana." Edgar J. Lott, Agricultural Extension Service, Lafayette, Ind.

Discussion.

Division of Watershed Management

Monday, October 25
Marvin D. Hoover, Chairman
Robert E. Dils, Vice Chairman
James J. Byrne, Secretary

Evening Session

1. Panel Discussion: "Do Foresters Face Watershed Management Problems in the Lake States?" Moderator: P. A. Herbert, Division of Conservation, Michigan State College, East Lansing, Mich.

Participants: Chester Wilson, Director (retired), Minnesota Department of Conservation, St. Paul, Minn.

R. D. McCulley, Lake States Forest Experiment Station, St. Paul, Minn.

F. G. Kilp, Nekoosa-Edwards Paper Company, Port Edwards, Wis.

K. W. Udd, U. S. Forest Service, Duluth, Minn.

2. Business meeting.

Division of Forest Products

Tuesday, October 26
R. C. Fraunberger, Chairman
Lincoln A. Mueller, Vice Chairman
Russell Stadelman, Secretary

Morning Session
Theme: "Recent Developments in Forest Products in the North Central States."

1. "A New Hardwood Pulpwood Creates Opportunities for Better Forestry in Ohio." W. H. Hildebrand, Mead Paper Corporation, Chillicothe, Ohio.

Discussion.

2. "Problems Resulting from Mechanization in Harvesting Forest Products." Leland J. Hooker, Forest Products Research Laboratory, Michigan College of Mining and Technology, Houghton, Mich.

Discussion.

3. "Trends in Machine Planting." C. A. Samuelson, William Bonifas Lumber Company, Marquette, Mich.

Discussion.

4. "Trends in the Veneer and Plywood Industry of the North Central States." H. O. Fleischer and T. R. Truax, both of the Forest Products Laboratory, Madison, Wis.

Discussion.

5. "The Effects of Recent Developments in Furniture Manufacturing on Wood Use." Stephen B. Preston, School of Natural Resources, University of Michigan, Ann Arbor, Mich.

Discussion leader: Fred E. Dickinson, School of Natural Resources, University of Michigan, Ann Arbor, Mich.

Division of Forest Recreation

Tuesday, October 26
Harthon L. Bill, Chairman
William N. Parke, Vice Chairman
Donald Duncan, Secretary

Morning Session

1. "The Contradiction of Wilderness Preservation in a Democracy." James P. Gilligan, Department of Forestry, Oklahoma Agricultural and Mechanical College, Stillwater, Okla.
2. "Management of the Itasca State Park Forest to Meet Recreational Objectives." Henry L. Hansen and Donald P. Duncan, School of Forestry, University of Minnesota, St. Paul, Minn.
3. "Recent Mining Activities in and adjacent to the Roadless Areas of the Superior National Forest." Galen W. Pike, U. S. Forest Service, Duluth, Minn.
4. "Quality Standards for Forest Recreation and Wildlife Production and Harvest." J. V. K. Wagar, Colorado A & M College, Ft. Collins, Colo.

Division of Silviculture

Tuesday, October 26
Philip A. Briegleb, Chairman
J. W. Duffield, Vice Chairman
Henry L. Hansen, Secretary

Morning Session

1. "A Decade of Development in Forest Practices: 1940-1950." Kenneth P. Davis, Department of Forestry, University of Michigan, Ann Arbor, Mich.
2. "The Gross Yield of Douglas-fir in the Pacific Northwest." George R. Staebler, Pacific Northwest Forest and Range Experiment Station, Olympia, Wash.
3. "Early Growth Response of Central Hardwoods to Management." Leon S. Minckler, Central States Forest Experiment Station, Carbondale, Ill.
4. "Hardwood Tree Grades as a Silvicultural Tool in the Management of Cumberland Plateau Hardwoods." Henry W. Smith, Jr., Department of Forestry and Engineering, The University of the South, Sewanee, Tenn.
5. "Where Does Thinning Fit into the Management of Lake States Pulpwood Stands?" Otis Hall, School of Forestry, University of Minnesota, St. Paul, Minn.

Afternoon Session

Symposium: "Coordinating Silvicultural Objectives and Practices with Wood Quality and Species Requirements in the Forest Industries."

Moderator: T. D. Stevens.

1. "Prospective Wood Quality and Species Requirements in the Forest Industries." J. A. Hall, Forest Products Laboratory, Madison, Wis.

2. "The Case for 'Cellulose' Forestry." Russell Watson, Consulting Forester, Manistique, Mich.

3. "Composition and Quality Objectives for the Aspen Type: Aspen Management in the Lake States." Z. A. Zasada, Lake States Forest Experiment Station, Grand Rapids, Minn.

4. "Silvicultural Problems in Central States Forests: Composition and Quality Objectives." L. E. Sawyer, Indiana Coal Association, Terre Haute, Ind.

5. "Successional Trends of Forest Vegetation and Future Wood Supplies." Henry L. Hansen, School of Forestry, University of Minnesota, St. Paul, Minn.

6. Report of Committee on Forest Tree Improvement. Scott S. Pauley, Harvard University, Petersham, Mass.

7. Other committee reports.

Division of Private Forestry

Tuesday, October 26

E. Stanley Hurd, Chairman
Arthur W. Nelson, Vice Chairman
Edwin J. Jankowski, Secretary

Afternoon Session

1. "The Lake States Council of Industrial Foresters. What Is it?" Bruce G. Buell, Northern Paper Mills, Green Bay, Wis.

2. "Industry Forest Management Research in the Lake States." B. L. Berklund, Nekoosa-Edwards Paper Company, Port Edwards, Wis.

3. "Industry Forest Management Research in the United States." W. H. Cummings and F. H. Kaufert, Society of American Foresters Forestry Research Project, St. Paul, Minn.

4. "Forests and the Mining Industry in the Lake States." R. H. Ewalt, The Cleveland-Cliffs Iron Company, Negaunee, Mich.

5. "Railroads and Forestry in the Lake States." W. A. Kluender, Chicago and North Western Railway System, St. Paul, Minn.

6. "Trees for Tomorrow—An Industrial Approach to Resource Management." M. N. Taylor, Trees for Tomorrow, Inc., Merrill, Wis.

Division of Forest-Wildlife Management

Tuesday, October 26

J. V. K. Wagar, Chairman
Ralph T. King, Vice Chairman
Herman F. Olson, Secretary

Afternoon Session

1. "Wildlife Management as a Part of Multiple-Use Forestry—Status and Prospects." Ralph T. King, Department of Forest Zoology, State University of New York, Syracuse, N. Y.

Discussion leader: Harold G. Wilm, College of Forestry, State University of New York, Syracuse, N. Y.

2. "The Wisconsin Cooperative Forest-Wildlife Program: The Forester's Viewpoint." Dan E. Bulfer, U. S. Forest Service, Rhinelander, Wis.

3. "The Wisconsin Cooperative Forest-Wildlife Program: The Wildlife Manager's Viewpoint." J. R. Smith, Game Management Division, Wisconsin Conservation Department, Madison, Wis.

4. Report of Committee to Integrate Professional Forestry, Range Management, and Wildlife Management Responsibilities. Paul Hickie, Fish and Wildlife Service, U. S. Department of the Interior, Denver, Colo. David F. Costello, U. S. Forest Service, Portland, Ore. Ralph R. Hill, U. S. Forest Service, Denver, Colo.

Joint Meeting

Wednesday, October 27

Division of Forest Economics and Policy

William A. Duerr, Chairman
Henry J. Vaux, Vice Chairman
M. B. Dickerman, Secretary

Division of Education

Kenneth P. Davis, Chairman
Archie E. Patterson, Vice Chairman
J. Whitney Floyd, Secretary

Morning Session

Symposium: "Economics in the General Forestry Curriculum."

1. "The Demand: What Training in Economics and Business Do Employers Want in the General Forestry Graduate?" Lawrence J. Kugelman, International Paper Company, New York, N. Y.

2. "The Supply: What Training in Economics and Business Are the Schools Giving the General Forester?" Albert C. Worrell, School of Forestry, University of Georgia, Athens, Ga.

3. "Some Ideas for Better Meeting the Demand."

"Through General Courses in Economics and Business." Paul G. Keat, College of Forestry, State University of New York, Syracuse, N. Y.

"Through Courses in the Economics of Forestry." Ernest Wohletz, College of Forestry, University of Idaho, Moscow, Idaho.

"Through the Teaching of Economics and Business in Other Courses." Allyn M. Herrick, Department of Forestry, Purdue University, Lafayette, Ind.

4. Comments.

"On the Demand." Russell N. Cunningham, Lake States Forest Experiment Station, St. Paul, Minn.

"On the Supply." Charles H. Stoddard, Independent Timber Farmers of America, Minneapolis, Minn.

"On the Proposals." Otis F. Hall, School of Forestry, University of Minnesota, St. Paul, Minn.

"By Way of Summary." J. Willcox Brown, School of Natural Resources, University of Michigan, Ann Arbor, Mich.

Division of Forest Management

Wednesday, October 27

Merle S. Lowden, Chairman
Myron B. Savage, Vice Chairman
R. Keith Arnold, Secretary

Morning Session

Protection

1. "Fire Control Progress in the Lake States." J. A. Mitchell, Lake States Forest Experiment Station, St. Paul, Minn.

2. Symposium: "Cooperative Approaches to Fire Control."

"Fire Compacts and Their Use." Arthur S. Hopkins, Northeastern Forest Fire Protection Compact, Chatham, N. Y.

"Cooperative Logging Slash Studies in Idaho." George Fahnestock, Intermountain Forest and Range Experiment Station, Missoula, Mont.

"Cooperative Suppression." R. C. Winkworth, Department of Conservation and Development, Raleigh, N. C.

"Operation Firestop." R. Keith Arnold, School of Forestry, University of California, Berkeley, Calif.

Discussion.

3. "Forest Insect Surveys in the Lake States." Daniel Benjamin, Department of Entomology, University of Wisconsin, Madison, Wis.

4. "Progress in Meeting the Oak Wilt Threat."

Afternoon Session

Photography and Mensuration

1. "Application of Area Control in Regulation." Perry Fassett, U. S. Forest Service, Cass Lake, Minn.

2. "Continuous Forest Inventory Using Business Machine Methods." John Wright, Union Bag and Paper Company, Savannah, Ga.

State Comments. Harold Kollmeyer, Michigan Department of Conservation, Lansing, Mich.

Industry Comments.

Discussion leader: A. E. Wackerman, School of Forestry, Duke University, Durham, N. C.

Forest Administration

1. Symposium: "Scientific Management in Forestry."

"Its Place in National Forest Administration." L. K. Mays, U. S. Forest Service, Portland, Ore.

"Its Place in State Forestry Administration."

"Its Place in Industrial Forest Administration."

"Its Place in Forestry Education."

2. "Where Does Thinning Fit into the Management of Lake States Pulpwood Stands?" Otis Hall, School of Forestry, University of Minnesota, St. Paul, Minn.

3. "Chemical Herbicides as a Tool in Forest Management." John Arend, Lower Peninsula Forest Research Center, East Lansing, Mich.

4. Business meeting.

Division of Range Management

Wednesday, October 27

M. W. Talbot, Chairman
Charles E. Poulton, Vice Chairman
Bert H. Tucker, Secretary

Afternoon Session

Panel Discussion: "Integration of Grazing and Timber Growing."

1. Introductory remarks by Chairman of the Division.

2. "Forest Grazing in the Deep South." Robert S. Campbell, Southern Forest and Range Experiment Station, New Orleans, La.

3. "Effect of Grazing on Timber in the Lake States." Fred B. Trenk, Extension Service, University of Wisconsin, Madison, Wis.

4. "Grazing and Timber Production in the Ozarks." George O. White, Missouri Conservation Commission, Jefferson City, Mo.

5. "Effect of Grazing on Ponderosa Pine Reproduction in the Southwest."

6. "Harmonizing Forestry and Range Management on the Pacific Coast."

Society Dinner

Wednesday, October 27

George Banzhaf, Toastmaster

Presentation of the Gifford Pinchot Medal by President E. L. Demmon.

Presentation of the Sir William Schlich Memorial Medal by President Demmon.

Address, "A Broad Look at Our Resource Problem." Reuben G. Gustavson, President and Executive Director, Resources for the Future, Inc., Washington, D. C.

Entertainment.

Ladies' Events

Ladies are cordially invited. There will be a special ladies lounge in the Schroeder Hotel with local hostesses on hand.

A tea has been arranged for Monday afternoon, October 25, to be followed by bridge, and possibly an evening concert.

On Tuesday, an auto tour with luncheon on the lake shore and a drive through Brown Deer Park and Wauwatosa. That evening members and their ladies have been invited to an evening of conviviality as the guests of the Milwaukee breweries.

On Wednesday morning there will be a tour of one of Milwaukee's art museums, followed by movies and lectures on the nationalities, customs, and costumes of Wisconsin, and on regional art. That evening the annual Society reception and dinner will be held in the Schroeder Hotel.

Hotel Reservations

All scheduled events will be held in the Schroeder, a hotel of 850 rooms. However, the Schroeder will not be able to accommodate all those attending the meeting, hence other hotels are cooperating.

Members should send reservation requests direct to the hotel of their choice. The reservation coupon printed herewith is for their convenience. Those who do not wish to clip the coupon from the JOURNAL may request a reservation by supplying the necessary information.

In any case, be sure to list first, second, and third choice hotels, and identify yourself as attending the meeting of the Society of American Foresters.

There follows a list of cooperating hotels in Milwaukee and their daily rates. They are listed according to size, and their convenience to the Schroeder. All room prices quoted are with bath, unless otherwise noted. Some hotels have rooms with connecting bath at lower rates.

Hotels

Schroeder Hotel, 509 West Wisconsin Avenue, Milwaukee 3. Single, $5 to $10; double, $7 to $10; twin beds, $8.50 to $12. Suites available.

Wisconsin Hotel, 720 North 3rd Street, Milwaukee 3. (Three blocks from Schroeder.) Single, $4.50 to $8; double, $6.50 to $10; twin beds, $9 to $10.

Medford Hotel, 607 North 3rd Street, Milwaukee 3. (Three blocks from Schroeder.) Single, $4 to $5; double, $6 to $7; twin beds, $7.50 to $9.

Plankinton House, 609 North Plankinton Avenue, Milwaukee 3. (Five blocks from the Schroeder.) Single, $5 to $10; double, $7 to $8.50; twin beds, $8 to $12.

Pfister Hotel, 424 East Wisconsin Avenue, Milwaukee 2. (Eight blocks from the Schroeder.) Single, $5 to $9; double, $7 to $10; twin beds, $7.50 to $12.

Tower Hotel, 11th & West Wisconsin Avenue, Milwaukee 3. (Six blocks from the Schroeder.) Single, $4.50 to $5; double, $5.50 to $7; twin beds, $6.50 to $8.

Towne Hotel, 723 North 3rd Street, Milwaukee 3. (Three blocks from the Schroeder.) Single, $4 to $6; double, $5 to $6.50; twin beds, $6.50 to $8.

In addition to the foregoing hotels, there are other good hotels outside the downtown area, and smaller hotels within the downtown area. A complete list of all city hotels and their rates may be obtained from the Convention Bureau, Milwaukee Association of Commerce, 611 North Broadway, Milwaukee 2, Wis.

Motels

Within a radius of fifteen miles from the Schroeder Hotel are at least two dozen motels and tourist courts with rates varying from $5 to $9 for a party of two.

A list of these motels can be obtained from the Association of Commerce, whose address is given above, or from the S.A.F. Committee on Hotel Reservations, the chairman of which is Edward Ritter, U. S. Forest Service, 623 N. 2nd Street, Milwaukee 3, Wis.

Meeting Committees

The general chairman for the meeting is H. Dean Cochran, regional forester, U. S. Forest Service, 623 North 2nd Street, Milwaukee 3, Wis.

Assisting him are the following committees and their personnel.

Program Committee

The chairman of the program committee is Kenneth P. Davis, School of Natural Resources, University of Michigan, Ann Arbor, Mich.

The other members are Bruce G. Buell, H. E. Ochsner, Clarence Prout, and L. E. Sawyer.

Arrangements Committee

The chairman of the Committee on Arrangements is Merle S. Lowden, U. S. Forest Service, 623 North 2nd Street, Milwaukee 3, Wis.

Assisting him is H. J. MacAloney and heading up the special task committees are the following:

Publicity: H. K. Pyles.
Reception: Fred G. Wilson.
Entertainment: Stanley Locke.
Hotel Reservations: Edward Ritter.
Meeting Rooms: John Von Bargen.
Field Stops: Allan Haukom.
Ladies Events: Mrs. Ray Bassett.

The President's Column

E. L. DEMMON

When the Society of American Foresters was organized in 1900 there was only a handful of professional foresters in the United States. Most of these had received training in Europe. There was no science of American forestry—this had to be developed over the years, with European forestry serving as a guide in the early decades. Now, after 50 years, American forestry stands on its own feet, with a science of its own. Its growth is reflected in the growth and activities of our Society, which now numbers almost 10,000 members.

For many years the Society accepted into membership any forestry school graduate who was properly qualified and recommended; later, only gradu-

Society of American Foresters
Annual Meeting
Milwaukee, Wis., October 24-27, 1954

, 1954

First Choice Hotel _____

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Third Choice _____

Please make a reservation for the following room accommodations

for arrival on October _____ a.m. p.m. Departure date, October _____.

I understand that accommodations will be provided at the daily rate specified, if available; otherwise the next nearest rate will apply.

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Twin-bed room with bath. Rate $ _____.

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Other (specify accommodations desired). _____

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The above room accommodations are requested for the following persons, in addition to myself. (Print or type names and addresses legibly.)

_____

_____

_____

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Street address: _____

City, zone, state: _____

FISCAL YEAR MEMBERSHIP CAMPAIGN

Section Box Score

Section	Applications received[1] Proposed 1954 quota	September listing	Total fiscal year
Allegheny	100	2	62
Appalachian	100	0	45
Central Rocky Mountain	45	1	25
Central States	110	0	79
Columbia River	140	2	52
Gulf States	105	0	53
Inland Empire	30	0	38
Intermountain	30	2	13
Kentucky Tennessee	30	0	5
New England	95	3	54
New York	65	0	39
Northern California	120	1	34
Northern Rocky Mountain	30	0	35
Ozark	55	4	47
Puget Sound	80	4	60
Southeastern	145	6	120
Southern California	20	0	2
Southwestern	35	0	7
Upper-Mississippi Valley	60	0	54
Washington	45	0	7
Wisconsin-Michigan	60	0	6
Totals	1,500	25	837

[1]Student, Junior, Affiliate, Associate (initial) grades only.

FISCAL YEAR MEMBERSHIP CAMPAIGN

School Box Score

School	Student applications received September listing	Total fiscal year
Alabama Polytechnic Institute	0	7
University of California	0	21
Colorado A & M College	0	17
Duke University	0	12
University of Florida	0	16
University of Georgia	2	38
University of Idaho	0	29
Iowa State College	0	26
Louisiana State University	0	14
University of Maine	1	16
University of Massachusetts	0	16
Michigan State College	0	25
University of Michigan	0	22
University of Minnesota	0	20
University of Missouri	1	20
Montana State University	0	19
State University of New York	0	23
North Carolina State College	0	19
Oregon State College	0	17
Pennsylvania State University	0	33
Purdue University	0	19
Utah State Agricultural College	0	8
University of Washington	1	28
West Virginia University	0	16
Yale University	0	3
Totals	5	484

ates of accredited forestry schools were acceptable for full Membership; more recently, requirements for the entering grade of Junior Member include graduation from an accredited forestry school, and a minimum of approved basic forestry courses (silviculture, forest management, forest protection, forest economics, and wood utilization). Of course, any well recommended forester who could demonstrate that he possessed the technical qualifications of the profession has always been eligible for membership.

The tendency in recent years has been towards more specialization in forestry as in all other professions. This is apparent in the expanded curriculums offered by forestry schools and in the available forestry jobs. Increased specialization also has brought about new societies—American Society of Range Management (1947), Soil Conservation Society of America (1941), Wildlife Society (1937), Forest Products Research Society (1947), etc. Foresters with specialized training or interest in these particular phases of land use or wood technology are thus offered outlets for their specialized interests.

Our Society, too, has become more specialized with the establishment of subject divisions. Since December 1933 eleven of these have been set up (Education, Forest Economics and Policy, Forest Management, Forest-Wildlife Management, Private Forestry, Public Relations, Range Management, Forest Products, Forest Recreation, Silviculture, and Watershed Management). These divisions provide opportunities for specialists or those interested in these various forestry fields to attend special sessions at the annual Society meetings, and to get together on other occasions. Their officers arrange these programs, stimulate interchange of ideas, and promote articles in these specialty fields for the JOURNAL. This is all to the good, and helps to keep our Society dynamic.

Some of our members are concerned that we may become too specialized and lose many of our members to other professional societies. Certainly our Society cannot satisfy all the wants of everyone engaged in activities bordering on forestry—wildlife, water, products, range, to mention a few. Yet we do welcome workers in these closely associated fields into our membership—if not as full members, then as Associates or Affiliates.

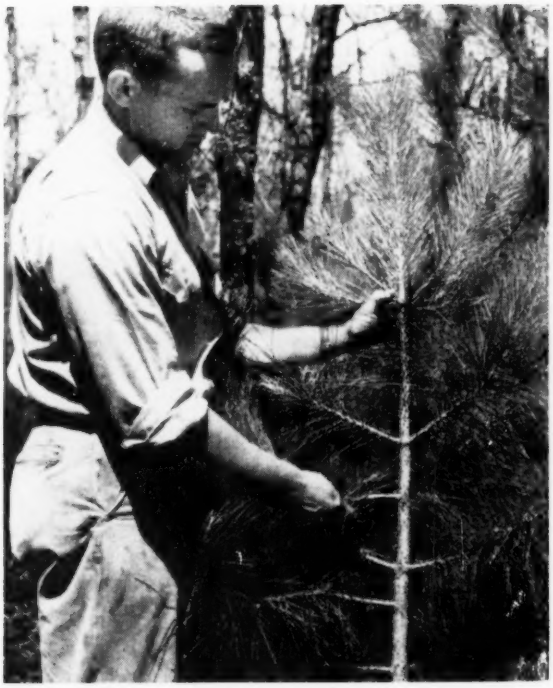
First and last, let us keep our Society tops as a professional organization. Let us keep our JOURNAL broad in its interests and our Society broad in its activities, the better to serve the profession and the public interest. Let us provide opportunities for all members, in all grades, and in all fields of interest, to participate in Society affairs to the maximum extent. As we conduct ourselves as professional foresters, so will we be accepted amongst scientists and the general public. Let's all work to make it so.

E. L. Demmon

Metropolitan Chapter Fall Meeting

The Metropolitan Chapter of the New York Section will hold its Fall meeting October 6. The program will be devoted to forest genetics headed by Dr. Ernst J. Schreiner.

Further particulars may be obtained from James B. Carlaw, International Paper Co., 220 E. 42nd St., New York 17.



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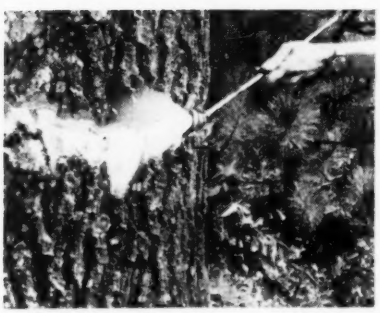

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Opportunities for Research in Natural Areas

In the JOURNAL OF FORESTRY, Volume 49, No. 11, November 1951 was an article "Scientific Use of Natural Areas." It showed some of the uses to which Natural Areas are adapted; uses for which, in the opinion of the Committee on Natural Areas, such areas are most valuable. The article also included information on the only known example of research being carried out formally in a recognized Natural Area. The conclusion reached was that the Natural Areas of the nation are not receiving the research use for which they are truly adapted.

In September 1953, the Food and Agriculture Organization of the United Nations published FAO Forestry and Forest Products Study No. 9 "Research in Forestry and Forest Products." It is of interest to review this publication to ascertain what research, relating directly to Natural Areas or which might utilize Natural Areas for research control plots, is underway throughout the world.

Three general types of research were found to be applicable:

1. Studies of the characteristics of forest soils under natural and disturbed conditions.

2. Studies of the biological characteristics of trees and shrubs; their requirements for light, heat, moisture, soil; their life habits, as a basis for silvicultural practices.

3. Studies on composition, site requirements, geographical occurrence, life habits, and succession of different types of forest vegetation, particularly the natural vegetation, as a basis for silvicultural practices and for evaluating yield possibilities.

Within these three general classifications FAO Study No. 9 lists the following research projects by countries.

Belgium. 1. To determine the physical, chemical, and biological characteristics of soils and their relation to occurrence of forest types and the behavior of natural regeneration.

2. To study the natural forest associations and succession.

Brazil. Studies on composition and synecology of virgin forests, especially the Itatiaia Park.

Canada. 1. To evaluate the methods of classifying forest areas according to production capacity and successful development by plant and tree associations.

2. To study natural areas and ecological reserves to determine natural development under undisturbed conditions.

Ceylon. To study factors affecting natural regeneration in:

1. Tropical dry mixed evergreen forests.

2. Tropical wet evergreen forests.

3. Sub-tropical montane wet evergreen forests.

Denmark. 1. To study the composition of the soil with regard to organic content, microflora and microfauna, as well as chemical changes under different conditions of surface vegetation.

2. To determine the reaction to environmental factors; to study root habits, seeding characteristics.

France and French Union. To study the soil development and associated vegetation.

Germany. 1. To determine life histories and reactions to environmental factors for different tree species, mostly in connection with research on forest vegetation, on site factors or on yield problems.

2. To make historical inquiries in order to get insights into the composition of natural forest vegetation.

India. Studies on succession in important forest communities in conifer

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forests of the Kulu and Bashar Himalayas for evaluating forest regeneration and extending plantations of useful species.

Israel. Studies of plant associations in relation to ecological conditions.

Italy. To study the ecological basis of European silviculture.

Japan. Studies of soil type and forest vegetation, natural and artificial regeneration.

Kenya. To study silviculture and enrichment of indigenous forest types.

Malaya. Plots are maintained for the study of plant succession in virgin jungle and in secondary growth.

The Netherlands. To provide exact figures of the influence on the sites and their soils affected by different plant associations.

New Zealand. To determine the reactions to environmental factors of important trees.

Norway. To study the soil development and associated vegetation, the production of various types of humus.

Spain. To study the requirements of the principal tree species.

Surinam. The study of the different forest vegetation types of the natural forest for those areas where surveys have been done.

Sweden. 1. To study the biological activity of soils, especially of different kinds of mull and mor.

2. To study the development of mycorrhiza on various species, particularly pine and spruce grown under different natural and artificial conditions.

Switzerland. 1. To study the seasonal progress of litter decomposition of the most important Swiss species on different soils.

2. To determine life histories and reactions to environmental factors for all important tree species, shrubs and herbaceous species.

3. To determine composition, structure, occurrence, site requirements and life histories of the natural forest plant associations.

United Kingdom of Great Britain and Northern Ireland. To study form, structure and natural regeneration of virgin forests both in temperate regions and in the wet tropics.

United States. By contrast the following projects are listed:

1. To determine life histories and reactions to environmental factors for the 150-odd important timber tree species and thousands of associated forest tree, shrub, and herbaceous species of the United States. This work is carried on at nearly all forest experiment stations for their regions.

2. To determine the ecological mechanisms involved in the natural replacement of one forest community by another—School of Forestry, Yale University.

From this brief analysis, it appears that this country is lagging behind much of the forest world in basic research projects relating to Natural Areas. However, two recent actions of national import are indicative of the increasing interest in this subject:

1. In the proposed program for American forestry as worked out at Higgins Lake, Michigan, in June 1953 and as presented to the Fourth American Forest Congress held at Washington, D. C., October 29-31, 1953, the following recommendation was made:

"Establishment of permanent study areas within virgin forest associations and other appropriate ecological areas in order to provide a more comprehensive knowledge of natural developments."

2. At the Mid-Century Conference on Resources for the Future, held at Washington, D. C., December 2-4, 1953, the digest on the consensus of opinion of those attending the Subsection on Wildlife, Scenic, Wilderness, and other Recreational Areas included the following:

"The subsection seemed to be in agreement that there is further need for more Natural Areas, many of which may be small, that must be left entirely alone except in special cases where a minimum of management may be desirable. In these areas plant and animal communities may be preserved as a sample of the native and original landscape. The value of such areas includes inspiration, outdoor laboratories for research and study, check-control areas to compare with managed lands and places where all plant and animal life has right to live. We need to preserve examples of many types of vegetation and natural features yet preserved."

The new listing of forest types preserved within approved Natural Areas starts on page 376 of the May issue of the JOURNAL OF FORESTRY. The Committee on Natural Areas again draws your attention to the many types not represented in approved Natural Areas and bespeaks your assistance in filling the gaps. It also urges your consideration toward using these approved Natural Areas for basic research or as check-control areas.

JOHN F. SHANKLIN, *Chairman,*
Committee on Natural Areas,
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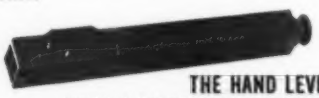

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JOURNAL OF FORESTRY
Mills Building, Washington 6, D. C.

Membership Applications and Advancements

Proposals for admission, advancement, and reinstatement received in the Society office during the month of July are listed below.

Action on the eligibility of those proposed for membership as listed below will be taken by the Council as of October 1, 1954. Communications from voting members regarding the membership eligibility of these persons should be received in the Society office prior to that date.

Allegheny Section

Junior Grade

Edinger, W. R., Forester, Pa. Dept. of Forests & Waters, Wellsboro, Pa.; Pa. State, B.S.F., 1951.

Land, F. W., Asst. Forester, Dept. of Forests & Waters, Bloomsburg, Pa.; Pa. State, B.S.F., 1948.

Central Rocky Mountain Section

Associate Grade

Hickie, P. F., Chief of Section, Fish & Wildlife Service, Denver, Colo.; Mich. State, B.S., (Applied Science), 1929; Univ. of Mich., M.S., (Mammalogy), 1931.

Central States Section

Member Grade

Davidson, J. B., Forester, Dept. of Cons., Springfield, Ill. (Junior, 39R47).

Larson, J. D., 303 East Monroe Street, Springfield, Ill. (Junior, 1946).

Columbia River Section

Junior Grade

McFarland, H. J., Asst. Forester, Rosboro Lbr. Co., Finn Rock, Ore.; Ore. State, B.S.F., 1951. Reinstatement.

Wear, J. F., Forester, U.S.D.A., Portland, Ore.; Univ. of Mich., B.S.F., 1947.

Affiliate Grade

McKinney, M. D., Instructor, Ore. State, Corvallis, Ore.; Mich. State, B.S., (Wood Utilization), 1949; Ore. State, M.S., (Forest Products), 1951.

Gulf States Section

Junior Grade

Edens, R. F., Forester, Edens-Birch Lbr. Co., Corrigan, Texas; Steven F. Austin State College, B.S., (Forestry), 1950. (Affiliate, 1952).

Affiliate Grade

Roraback, G. L., Box 334, Quitman, Miss. Reinstatement.

Intermountain Section

Junior Grade

Doupe, W. W., Forester, U.S.F.S., Boise, Idaho; Univ. of Idaho, B.S.F., 1938.

Affiliate Grade

Murray, W. E., Forester, U.S.F.S., Fairfield, Idaho; Utah State Agric., B.S., (Forestry), 1941.

New England Section

Student Grade

UNIVERSITY OF MAINE

Evans, W. M.

Junior Grade

Marsh, J. W., Supv., Keep Maine Green, Maine Forest Service, Augusta, Maine; Univ. of Maine, B.S., (Entomology); M.F., 1938.

Thorne, T., Forester, Baboosic Brook Watershed, Milford, N. H.; Univ. of Mich., M.F., 1954.

Northern California Section

Affiliate Grade

Merle, W. E., Project Supv., Calif. Div. of Forestry, Auburn, Calif.

Ozark Section

Student Grade

UNIVERSITY OF MISSOURI

Barnhart, F. T.

Junior Grade

Lord, J. S., Dist. Forester, Dierks Lbr. & Coal Co., Umpire, Ark.; L.P.I., B.S., (Forestry), 1950. (Affiliate, 1952).

Member Grade

Wilson, J. S., Field Asst., International Paper Co., Nashville, Ark.; L.S.U., B.S.F., 1940. (Junior, 41R51).

Affiliate Grade

Green, W. E., Forestry Aide, Southern Forest Expt. Sta., Calico Rock, Ark.

Miller, R. L., Grad. Student, Okla. A & M, Stillwater, Okla.; Okla. A & M, B.S., (Forestry), 1953.

Associate Grade

Bowers, H. D., Dist. Supt., International Paper Co., DeQueen, Ark.

Puget Sound Section

Student Grade

UNIVERITY OF WASHINGTON

Moyer, J. A.

Junior Grade

LeMay, W. V., Forest Engr., Northwest Door Co., Tacoma, Wash.; Univ. of Wash., B.S.F., 1942.

Zito, J., 430 Summit, Fircrest, Tacoma, Wash.; Univ. of Wash., B.S.F., 1950.

Associate Grade

Hupe, R. W., Dist. Game Biologist, Wash. State Game Dept., Olympia, Wash.; Ore. State, B.S., (Fish & Game Mgmt.), 1947.

Southeastern Section

Student Grade

UNIVERSITY OF GEORGIA

George, W. C. Teate, J. L.

Affiliate Grade

Martin, S. M., County Ranger, Ga. Forestry Comm., Madison, Ga.; Univ. of the South, B.S., (Forestry), 1949.

Tomlinson, C. E., 825 Sherrod Ave., Florence, Ala.; Univ. of the South, B.S., (Forestry), 1954.

Associate Grade

Sizemore, M. E. H., Partner, William R. Sizemore & Co., Tallassee, Ala.

Smith, W. D., Chief Forester, Buckeye Cellulose Corp., Foley, Fla.

Forestry News

American Forestry Association Meets

The American Forestry Association will convene September 6 through 9 in Portland, Oregon, for its 79th annual meeting.

Feature of the event is a special train, the "Conservation Caravan," which will leave Chicago August 30, making a grand circle tour of the West enroute to and from the meeting. It will stop at various points of interest, including several national parks, and will return to Chicago September 17.

This is AFA's first meeting in the Pacific Northwest and it is expected that several hundred persons will be in attendance, including foresters, industrial representatives, private citizens, and public servants interested in the nation's natural resources.

AFA executive director-forester, Lowell Besley, reports a diversified program for the meeting. One day will be devoted to business sessions and the remaining three to field trips. Keynote speaker will be Charles A. Sprague, former governor of Oregon, while Governor Patterson (Ore.) and William B. Greeley will be principal speakers at the banquet.

Giant Alaska Pulp Mill in Operation

The first pulp mill in Alaska was dedicated July 14 at Ward's Cove, a few miles from Ketchikan. The $52,500,000 plant of the Ketchikan Pulp Company will produce more than 100,000 tons of pulp per year, was built at a cost over seven times the figure paid Russia by the U. S. in 1867 for the Territory, and represents the first major industrialization of the region since the advent of salmon canning and mining. No small portion of the credit for this development can be attributed to Territorial Governor Frank H. Heintzleman, longtime Forest Service supervisor in Alaska and staunch supporter of forest development.

Perpetual operation of the mill is based on the Tongas National Forest by a timber contract between the company and the U. S. Forest Service that assures proper handling of the forest for present and future supplies.

About 900 persons will be employed in the mill and logging operations.

Ketchikan Pulp Company was formed by Puget Sound Pulp & Timber Company of Bellingham, Wash., and American Viscose Corporation of Philadelphia. The latter concern manufactures rayon and transparent wrapping material and has contracted for most of the mill's production for 20 years.

Royal Scottish Forestry Society's Centenary Year

The Royal Scottish Forestry Society, the oldest forestry society in the English-speaking world, is celebrating its centenary year. It was instituted in

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1854 as The Scottish Aboricultural Society.

Scottish Forestry is the Society's official journal. The four issues for 1954 will constitute the centenary volume. A history of the Society was published in the January issue.

Southern Institute of Genetics Established at Gulfport, Miss.

The South now has its own regional forest genetics center. It is the Southern Institute of Forest Genetics at Gulfport, Miss., which was officially established by the U. S. Forest Service on July 1.

This new center is the outgrowth of a cooperative study by the U. S. Forest Service and the Forest Farmers Association of Atlanta, Georgia, on how forest genetics activities in the South might best be furthered.

All conclusions indicated that establishment of a regional genetics institute would offer the best means to accomplish this end. The Southern Institute of Forest Genetics will function as part of the Southern Forest Experiment Station at New Orleans, La. Its work will be similar in scope and purpose to that of the U. S. Forest Genetics Institute at Placerville, Calif.

In general the new center's program will be directed at the fundamental aspects of forest genetics research, with special emphasis on southern problems. While all its work will be coordinated through the Gulfport headquarters, various projects will undergo further testing on existing experimental forests and other locations over the South where qualified researchers are available.

Facilities including a headquarters office, laboratory and greenhouse, now available on the Harrison Experimental Forest, will house the new institute. Meanwhile, the Forest Service reports it will shortly announce staff appointments. When fully assembled, the staff will include several scientists in genetics and related fields, plus a number of non-professional technicians and clerks.

Initially, the Southern Institute of Forest Genetics has an annual budget of approximately $45,000 in federal funds. It is hoped to double this shortly through private cooperative participation. The Forest Farmers Association is now sponsoring formation

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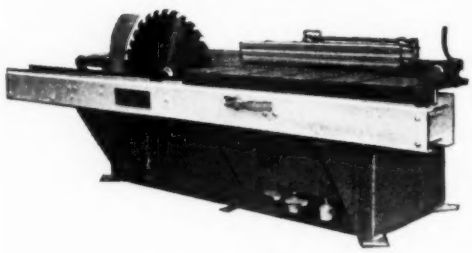

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SECRETARY OF AGRICULTURE, Ezra T. Benson, presents a bronze plaque to officials of the Association of State Foresters, The Advertising Council, and the U. S. Forest Service in recognition of the work which these organizations are doing through the nationwide Cooperative Forest Fire Prevention Program. (Left to right: Fred H. Claridge, state forester of North Carolina; Theodore S. Repplier, president of The Advertising Council; Secretary Benson; and Richard E. McArdle, chief, U. S. Forest Service.)

This presentation took place recently in Washington, D. C., at a meeting during which The Advertising Council presented the proposed Smokey Bear Forest Fire Prevention Program for 1955.

Attending the meeting were representatives of the National Association of Manufacturers, American Forest Products Industries, American Forestry Association, Red Cross, Boy Scouts, Girl Scouts, National Board of Fire Underwriters, National Fire Protection Association, Sports Fishing Institute, National Wildlife Federation, Associated Tobacco Manufacturers, National Park Service, Bureau of Land Management, National Lumber Manufacturers Association, Society of American Foresters, National Commission on Safety Education, Institute of Life Insurance, Izaak Walton League, Saturday Evening Post, Columbia Broadcasting System, The White House, Forest Service, and state foresters from North Carolina, Kentucky, and Colorado.

This marked the 14th consecutive year that the state foresters, U. S. Forest Service, and The Advertising Council have worked together in planning the nationwide Cooperative Forest Fire Prevention Program. This program was started in 1942 and it is now paying real dividends in the conservation of our forest resources. For the five-year period prior to 1942, there was an average of 205,047 forest fires a year in the United States. For the past five years there has been an average of 181,741 forest fires a year, or an average decrease of 23,306 fires a year as compared with pre-campaign figures. This result has been achieved in spite of the fact that public use of forested areas has increased 100% over pre-campaign levels. This encouraging progress has been due in large part to the splendid support which American business, Keep Green Associations, Red Cross, Boy Scouts, Girl Scouts, Camp Fire Girls, 4-H Clubs, Federated Womens Clubs, Izaak Walton League, Forest Industries, and numerous other organizations have given this program. In 1953, American business contributed over $7,000,000 worth of free advertising time and space in support of the Smokey Bear Program.

of a Southern Forest Research and Genetics Foundation, which would assist.

Southern Forest Tree Improvement Meeting

The Third Southern Forest Tree Improvement meeting will be held January 7-8, 1955 in New Orleans.

Since the last southwide meeting in January 1953, advances have been made in the application of genetics in southern forestry. Active research programs are being sponsored by the Southern and Southeastern Forest Experiment Stations; a number of state forestry agencies, paced by the Texas Forest Service; numerous private corporations; Tennessee Valley Authority; and several of the forestry schools. Adoption of tree improvement prin-

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ciples in forest practice is being accelerated.

D. A. Anderson, Texas Forest Service is chairman of the committee on program and arrangements. Other members are George Garin, Department of Forestry, Alabama Polytechnic Institute and Philip C. Wakeley, Southern Forest Experiment Station. They are planning for a two-day meeting that will bring together outstanding authorities on tree improvement and genetics from the South and the nation.

Industrial & Private

J. E. McCaffrey Heads Southern Craft Woodlands Operations

The Southern Kraft Division, International Paper Company announces the appointment of J. E. McCaffrey to the position of assistant general manager in charge of woodlands operations.

J. E. MCCAFFREY

Mr. McCaffrey has been located at the company's Georgetown, South Carolina, mill as division superintendent, woodlands department, ever since his retirement from military service in 1946. He first was associated with International Paper in 1928 and after having left the company briefly during the thirties, he rejoined in 1937 as division forester for the Arkansas-Louisiana area.

In 1938, McCaffrey was called to division headquarters in Mobile, Ala., to help organize a central woodlands office. He served as general superintendent of timberlands until 1940 when he was named general super-

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intendent of wood procurement. He resigned from the company in 1942 to rejoin the United States Army Corps of Engineers, reverting to inactive status with the rank of Colonel in 1946.

McCaffrey is a graduate of the New York State College of Forestry Ranger School and is a member of the Society of American Foresters and the Society of American Military Engineers. He is a past president of the American Pulpwood Association and is presently a director of the Forest Geneties Research Foundation and a member of the advisory board, American Forest Products Industries.

H. H. Flickinger, who has served as assistant division superintendent of woodlands in Georgetown, has been named to replace Mr. McCaffrey. A graduate of both the New York State College and Yale University schools of forestry, he has been connected with International Paper since 1946.

W. C. Hammerle Joins New Marketing Institute

W. C. Hammerle formerly with the Southern Pine Association and more recently with the Forest Farmer's Association, has assumed the position of executive secretary of the Southeastern Pine Marketing Institute. This is a newly formed association of lumber manufacturers in the Carolinas, Georgia, and Florida set up to promote the marketing of trade marked lumber, properly manufactured and graded by the member mills. Mr. Hammerle reports that the organization's undertaking will be somewhat similar to that of the Arkansas Soft Pine Bureau and of such a nature that it does not duplicate or compete with the Southern Pine Association. Subsequently headquarters will be set up at Savannah, Georgia.

R. F. Haussman Joins Lumber Concern

R. F. Haussman has resigned his position with the U. S. Forest Service to become general manager and forester of the John W. Morgan Lumber Company at Pittsfield, Penn. At the time of leaving the Forest Service, Haussman was resource management staff forester on the Allegheny National Forest. He has spent 20 years with the service in various part of the East. In addition to his new duties Haussman expects to handle such outside consulting work as time will permit.

A. C. Klotz Heads Tacoma Office of AFPI

Alvin C. Klotz has recently assumed the position as head of the American Forest Products Industries' new field office in Tacoma, Wash. His new territory includes the states of Washington, Montana, Idaho, and Wyoming. All western activities prior to the establishment of the Tacoma office were handled by the Portland office.

Klotz graduated from the College of Forestry at the University of Washington, and was formerly associated with Miller Freeman Publications.

G. K. Gunderson Joins Dalton-Brundy Company

Glenn K. Gunderson has joined the sales staff of the Dalton-Brundy Lumber Company of Norfolk, Va. He has previously been with the American Hardware Company of Petersburg, Va., and with the Tennessee Valley Authority. Gunderson received his masters degree from the University of Michigan in 1941. He served with an Army Engineer Forestry Company in Burma during the war.

Government

Col. H. B. Donaldson in Korea

Col. H. B. Donaldson, Eighth Army forester and reforestation officer in Korea, was assigned on July 2 to command the 19th Infantry Regiment on duty there.

A graduate (1933) of the College of Forestry at Syracuse, he was with the U. S. Forest Service until the start of World War II.

In June Col. Donaldson supervised the planting by helicopter of 500

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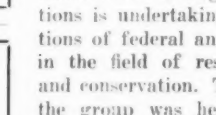
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pounds of quick-germinating mustard seed, the start of a program to revegetate denuded Korean hillsides for the prevention of soil erosion and as preparation for the planting of a million seedlings next spring.

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Federal-State Conservation Relationships Study

A special committee of the Commission on Intergovernmental Relations is undertaking to consider questions of federal and state relationship in the field of resource management and conservation. The first meeting of the group was held in Washington, D. C., in July under the chairmanship of William S. Rosecrans of Los Angeles, chairman of the California Board of Forestry and past president of the American Forestry Association. This is the first federal study of the whole broad field. Work on its consideration has begun by mailing questionnaires to conservation leaders throughout the country inviting special attention to nine major subjects: (1) Should federal aid in state and private forestry and fish and wildlife restoration be continued? Are they effective? Can they be improved? Are additional federal grants needed? (2) What are the federal and state responsibilities in natural resource development and management on wild lands and what should be the technical and financial relationships? (3) Should the federal government make grants-in-aid for regulation of timber cutting? (4) Should there be a change in federal policy in water resource development as affects states and local governments? (5) Should there be any change in federal policy as relates to flood control, multi-purpose projects and hydro-electric power? (6) How can the federal government exercise control over navigation on water development projects? (7) What are the respective responsibilties of all levels of government in controlling stream pollution and improvement? (8) What is the best way to promote basin-wide development of natural resources on all levels? (9) Are any changes needed in federal-state conservation of commercial fisheries? Included in this 12-man committee are two foresters, S. T. Dana, University of Michigan, and Bernard L. Orell, vice president, Weyerhaeuser Sales Co., St. Paul, Minn. Other members represent various fields in the resource picture.

Trinity and Shasta National Forests Combined

The Trinity and Shasta National Forests in northern California were administratively consolidated in July into a combined forest with headquarters located in Redding, according to a statement by Regional Forester Clare Hendee, U. S. Forest Service.

The Goosenest District of the Shasta will become a part of the Klamath National Forest with headquarters in Yreka, Calif. The balance of the Shasta and the Trinity will be combined into one administrative unit to be known as the Shasta-Trinity National Forest. Paul W. Stathem, recently named Supervisor of the Shasta will be in charge of the newly consolidated unit.

This consolidation "is a continuation of a long established policy of the Forest Service directed toward provid-

Forestry Employment

S.A.F. members are privileged to insert one 60-word advertisement in this column without charge. Forest industries desiring to employ foresters may insert advertisements at the rate of $4 per column inch. Copy must be received by the end of this month for an advertisement to appear in the issue after next.

Obviously, the Society cannot assume responsibility beyond making it possible for prospective employee and employer to enter into negotiations.

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Forester, 34. B.S.F., N. C. State, M.F. in Forest Management, Duke Univ. Married, one child; Navy veteran; 6 years well-rounded experience with private industry, state, and U. S. Forest Service, including cruising, type mapping, surveying, timber marking, timber sales administration, pulpwood production, fire control, and public relations. Now employed as supervising forester by federal agency. Desire position requiring a minimum of travel.
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ing better service to forest users." Resultant savings by reducing overhead costs will be used to expand much needed field operations and services.

During the past two years similar consolidations have been made in other regions whereby 16 national forests have been combined into 8 administrative units.

Redding was selected as headquarters of the new Shasta-Trinity National Forest because of its growing importance as the center of industry and other forest user business in northern California. Forest Service equipment, supply and construction services for all of northern California forests are now located in Redding. Existing government facilities will be used for the new forest headquarters. Former forest headquarters facilities at Mt. Shasta and Weaverville will serve as ranger district and project headquarters.

D. B. Stickney to Information Post

Appointment of Donald B. Stickney to a staff position in the Division of Information and Education, Portland Regional Office of the Forest Service, has been announced by Regional Forester J. Herbert Stone.

Stickney comes to his new position as information specialist from the Powers District, Siskiyou National Forest, where he has been district ranger since 1944. He replaces Elwyn Peffer, recently assigned to the Leavenworth District, Wenatchee National Forest, Wash.

In his new position, Stickney will be in charge of the Smokey Bear Cooperative Forest Fire Prevention campaign, in addition to other general information duties.

Stickney was graduated from the University of Washington with a Bachelor of Arts degree in 1931. He returned to earn a Bachelor of Science degree in forestry in 1939.

Michigan Research Council Meeting

The Lower Peninsula Forest Research Council held its sixth annual meeting June 3 and 4 at Grand Rapids, Michigan. The first day was spent in the field reviewing active research projects and management problems. The second day was spent reviewing significant research results and plans of agencies in the Lower Peninsula of Michigan.

L. C. Palmer, forester for the Kent County Road and Park Commission served as chairman of the Council during the past year and, along with Gordon B. Bonfield, vice-president of the American Box Board Company, served as host for the annual meeting.

T. D. Stevens, head of the forestry department, Michigan State College, was elected chairman for next year. John L. Arend, forester in charge of the Lower Peninsula Forest Research Center is permanent secretary.

This research council was organized by the Lake States Forest Experiment Station in March 1949 to serve as an advisory committee to its Lower Peninsula Forest Research Center. The council was exceptionally helpful in guiding the research programs of the Lower Peninsula Forest Research Center and in coordinating the work of other research agencies. In 1951 the advisory council voted to broaden its scope to include other agencies conducting forest research in the Lower Peninsula of Michigan.

The council is composed of 12 members, 5 from public agencies and 7

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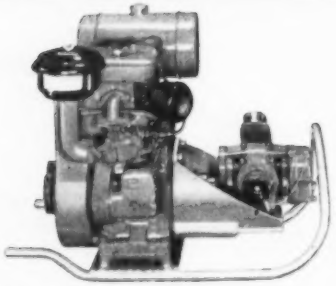

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Gallons per minute	40	38	37	36	35	32

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members at large. The public agencies are the University of Michigan, Michigan State College, Michigan Department of Conservation, Lake States Forest Experiment Station, and the Lower Michigan National Forest. The 7 members at large are selected from Michigan Forest Industries Information Committee, pulp and paper companies, private and consulting foresters for a term of 2 years, and a chairman is elected annually.

Forest Service Transfers Supervisors in California

The transfer of six National Forest supervisors in the California Region of the Forest Service was made in July, according to Regional Forester Clare Hendee.

Paul W. Stathem, assistant in the Division of Information and Education, San Francisco, will be the new supervisor of the Shasta National Forest. The vacancy in the San Francisco office is to be filled by William F. Fisher, present supervisor of the Six Rivers National Forest with headquarters at Eureka.

Wesley W. Spinney of Placerville, supervisor of the Eldorado National Forest, is to take over the Six Rivers National Forest post, behind Fischer. The vacancy at the Placerville headquarters will be filled by Guerdon Ellis, present supervisor of the Tahoe National Forest with headquarters at Nevada City.

L. A. Rickel, Jr., supervisor of Los Padres National Forest, with headquarters at Santa Barbara, is being transferred to Nevada City to head up the Tahoe National Forest. Roberts E. Jones, present supervisor of Shasta National Forest, will fill the vacancy created at Santa Barbara.

A selection had not been announced to fill the Fresno vacancy on the Sierra National Forest which occurred with the promotion of Byron B. Beattie to assistant chief of fire control in Washington, D. C.

Forest Service Transfers Supervisors in Northern Region

Two reassignments for forest supervisors in the Northern Region of the U. S. Forest Service were made in May and announced by Regional Forester P. D. Hanson.

Fred I. Stillings, supervisor of the Clearwater National Forest in Idaho, took up his duties with the Division of Engineering in the regional office at Missoula. Ralph S. Space, formerly supervisor of the Cabinet National Forest, succeeded Stillings as supervisor.

Education

Forestry Celebrates Golden Anniversary at Iowa State

A two-day celebration at Homecoming time, October 15 and 16, will mark the fiftieth anniversary of professional education in forestry at Iowa State College, Ames.

The forestry department will welcome all alumni and former students, as well as their parents, wives, and friends to an open house in its newly remodeled quarters on the second floor of Curtiss Hall. On the program there and at Memorial Union will be discussions, presentation of awards, tours, and special entertainment for the ladies. A memorial is to be dedicated to Prof. G. B. MacDonald who headed the forestry department from 1910 to 1948.

Iowa State became a pioneer in the field by first offering a formal college course in forestry in 1874. Until 1904 forestry was part of the general program in agriculture, but in that year Hugh P. Baker was employed to take charge of the teaching, and the professional program was begun.

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Iowa State has reason to be proud of its record in forestry education and the performance of its students in their profession. Their numbers are near the one thousand mark as the college enters its second half century of leadership.

Yale Receives Hartford Foundation Grant

Some 300 acres of the Valhalla, N. Y., property of the John A. Hartford Foundation has been leased to the Yale University School of Forestry for a new program of research and education in forest biology.

The Foundation, founded by the late John A. Hartford who was President of the Great Atlantic & Pacific Tea Co., will also support the new science project with annual grants to Yale for the next 15 years. Amount of the grants wll be determined later.

The announcement was made by President A. Whitney Griswold of Yale and President Ralph W. Burger of the Foundation.

The grants will be used by Yale to add nine new scientists to its forestry faculty, and to provide for research and training of graduate students in forest biology. Headquarters for the research section will be at Valhalla while the instructional program will be centered in New Haven.

George A. Garratt, dean of the Yale School of Forestry, in outlining plans for the program, stated that "the generous grant of The John A. Hartford Foundation represents an act of philanthropy without parallel in the history of forestry science.

"These grants will support a long-needed attack on biological problems which must be solved if American forests are to become a permanently productive segment of our national economy."

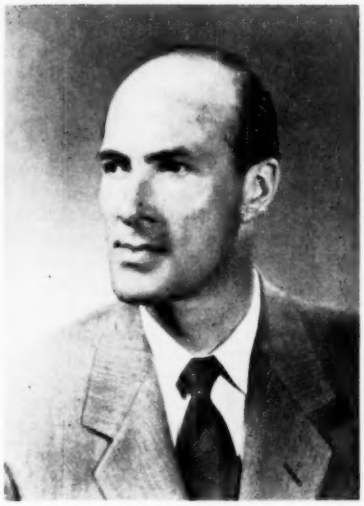
The forest biology program will cover such major areas of study as tree physiology, xylology, forest soils and insects, as well as the genetical and meteorological aspects of forest production. The Valhalla project represents the greatest expansion in the work of the Yale School of Forestry since it was established in 1900.

The annual grants include five major fellowships for advanced students working for Ph.d. degrees in forest biology. These men will also serve as assistants on research projects.

Charles Larson Awarded Ford Study Grant

Dr. Charles C. Larson, research assistant in forest economics at the State University of New York College of Forestry, has been awarded a Ford Foundation grant to study forest resources in the Middle East and South and Southeast Asia.

Larson, who will introduce a course in World Forestry at the college this fall, will leave on a round-the-world trip in January. He will confer with forestry officials in England and with representatives of the forestry division of the FAO of the United Nations in Rome. He will then proceed to Turkey, India, and Pakistan for extended study and to Burma, Java, Thailand, Philippines, and Japan for conferences and observation tours.



CHARLES C. LARSON

The purpose of Larson's study is to become acquainted with the forestry problems of the countries in the Middle East and South and Southeast Asia, and to study the foreign programs with special emphasis on education and research. Since more and more foreign students are coming to the United States for professional training, the study has as its principal objective to determine how American forestry colleges may best adjust curricula to needs of foreign students and to provide specialist training in world forestry for a selected number of American students.

Larson completed his undergraduate

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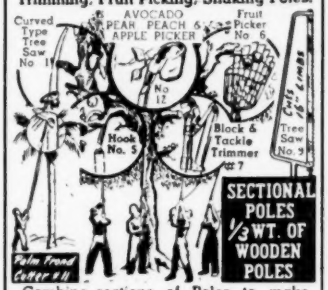
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training in forestry at the University of Minnesota in the fall of 1940, received a Master of Science degree in 1943 from the University of Vermont, and his Ph.D. from the State University of New York College of Forestry in 1952.

Since 1950 Dr. Larson has been a member of the College of Forestry research staff with major responsibility for carrying out a comprehensive study of the Adirondack forest economy. He will return to the College in September of 1955 to resume teaching the course in world forestry and to organize a curriculum designed to provide specialist training in this sphere.

T. W. Bretz Joins Missouri Teaching Staff

Dr. Theodore W. Bretz has been appointed professor of forestry at the University of Missouri effective September 15, announces R. H. Westveld, chairman of the department of forestry.

Since 1945, Bretz has been in charge of forest disease investigations for the U. S. Department of Agriculture with headquarters in Columbia. His main investigations prior to 1950 were on elm virus diseases and since that time, oak wilt.

Before joining the USDA in 1943, he taught plant pathology at Cornell University, Ithaca, N. Y., and Texas Agricultural and Mechanical College, College Station, Texas.

A native of Ohio, Bretz received his bachelor of science degree in agriculture from Ohio State University, his master of science from Iowa State College and his doctor of philosophy from Ohio State.

He holds membership in various professional organizations and is a member of the section of forest protection, International Union of Forest Research Organizations. Bretz also has been a member of the National Oak Wilt Research Technical Committee and the North Central Regional Oak Wilt Committee.

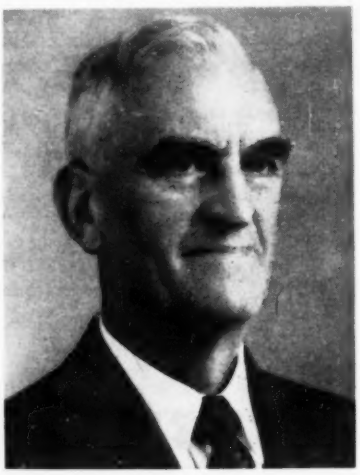
Washington Scholarship Awarded

The University of Washington College of Forestry announces the awarding of the U. M. Dickey Scholarship to Peter Johnson of Skamokawa, Wash. The scholarship was established by the Scott Paper Company in 1952 "in honor of Mr. U. M. Dickey in recognition of the great contributions he has made and is making to the constructive development and utilization of forest resources and the tremendous stimulus his achievements afford to those interested in forestry." The scholarship is awarded to a student in the College of Forestry at the end of his sophomore year on the basis of character, leadership, and scholarship. The recipient receives an annual award of $1,000 in his junior and senior years.

Johnson is the third student to receive this award.

Emanuel Fritz Retires from Teaching Post

Emanuel Fritz, widely known throughout the forestry profession, is retiring as professor of forestry at the University of California. While most of his career has been at the university, beginning in 1919, he has also served with the Forest Service and lumber trade associations. He helped found the Redwood Region Logging Conference and has been secretary since 1935. He has been active in industrial forestry through his writing and speaking and his work in redwoods is widely known.



EMANUEL FRITZ

Professor Fritz is a Fellow of the Society of American Foresters and past editor of the JOURNAL. He includes among his affiliations the Forest Products Research Society, American Wood Preservers Association, American Society of Mechanical Engineers, Western Forestry and Conservation Association, Sierra Club, Bohemian Club, and the Wilderness Society. It is expected that he will continue active professional work as a consultant and in the fields of his related interests.

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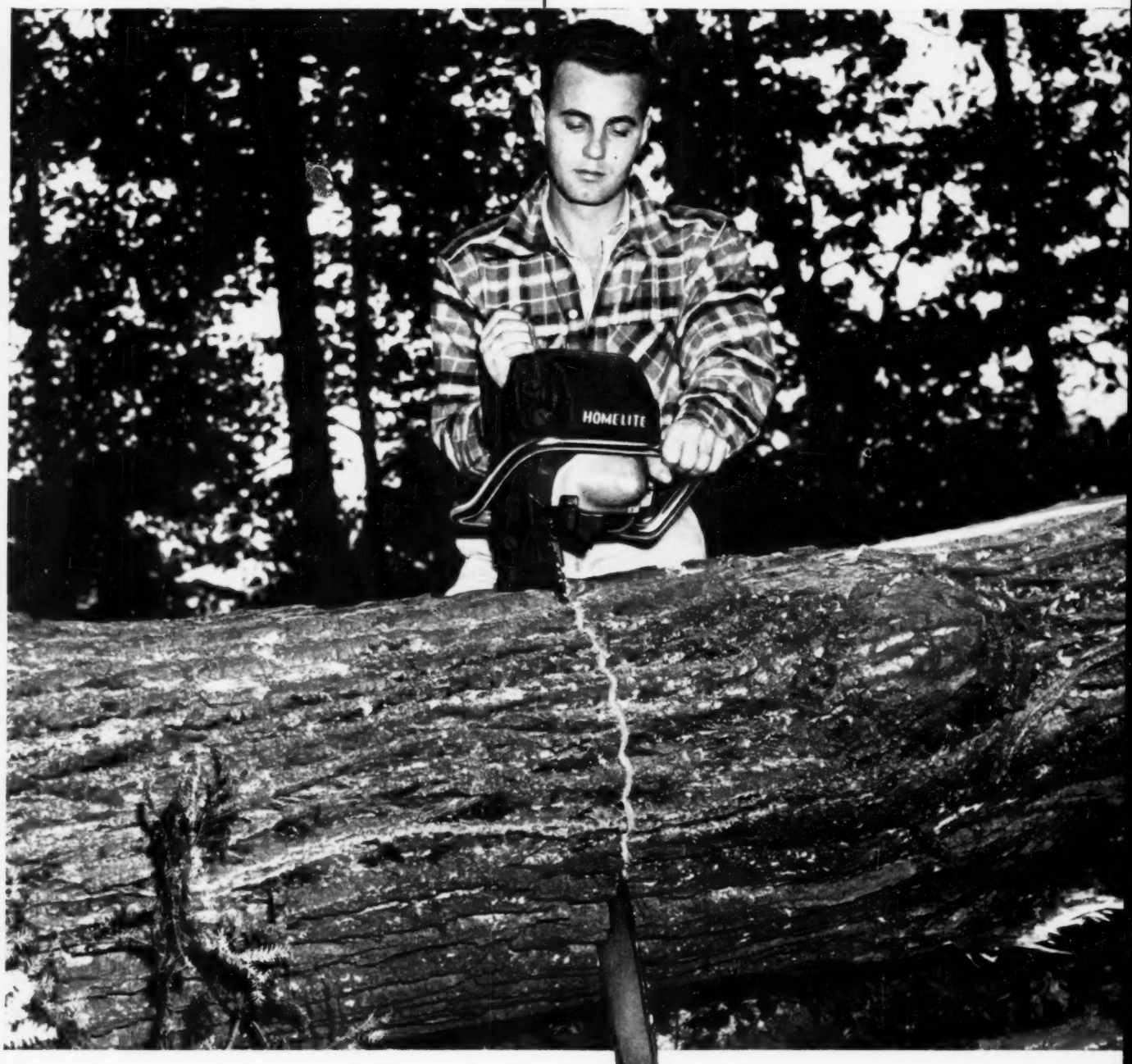

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